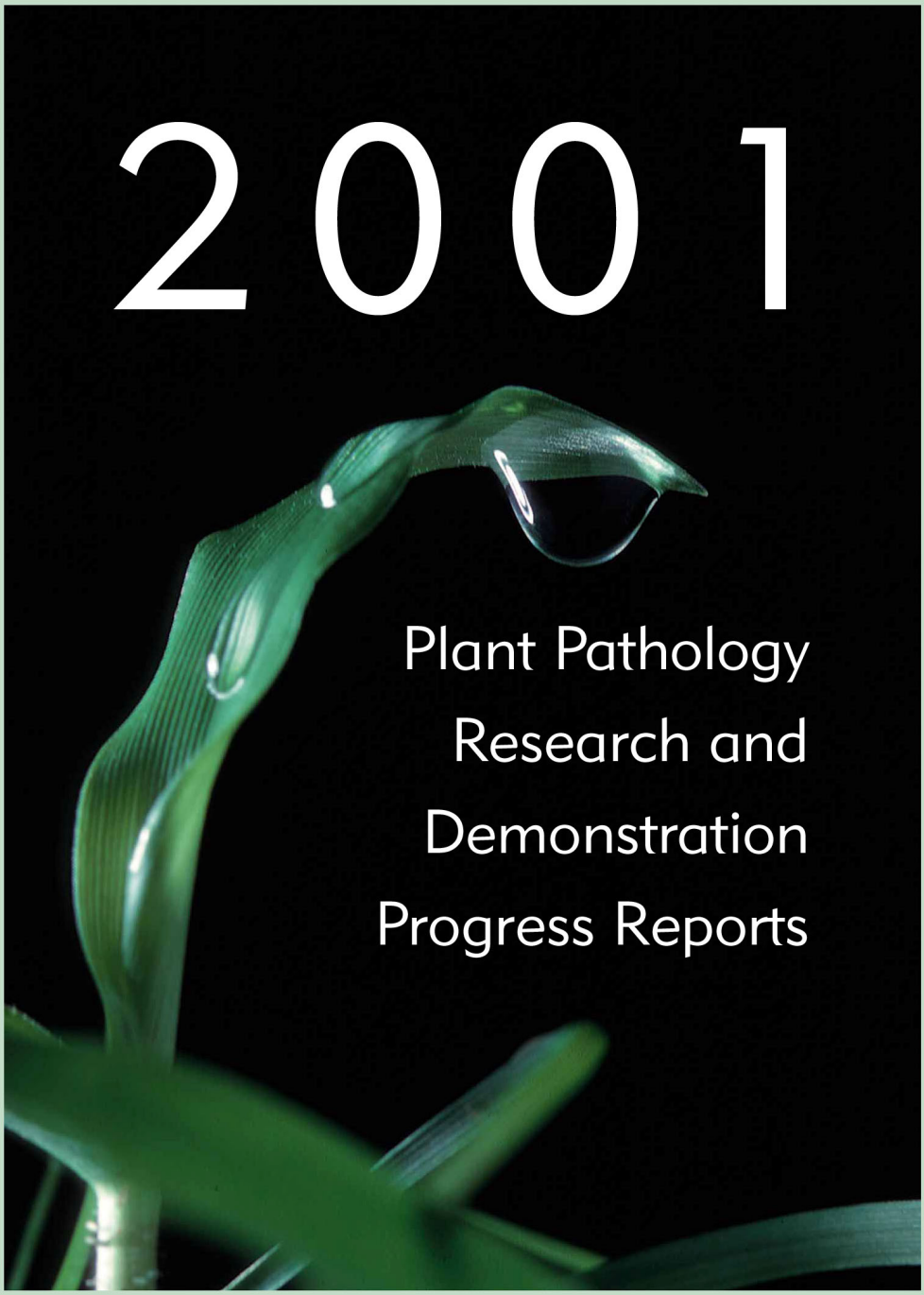
2001



Plant Pathology Research and Demonstration Progress Reports

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Additional copies are available by calling (307) 766-2397 or by e-mailing FrancG@uwyo.edu. This report will also be published during the spring of 2002 as MP101-02 and will be available from the University of Wyoming Agricultural Experiment Station Web site as MP101-02

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Research Project	**Bean Rust Management with Foliar Fungicides, 2001**
Research Team Tel: 307-766-2397 FAX: 766-5549 francg@uwyo.edu	G.D. Franc, W.L. Stump, and J.T. Cecil University of Wyoming, Dept. of Plant Sciences P.O. Box 3354 (16th & Gibbon Streets) Laramie, WY 82071-3354
Field Plot Location	Torrington Research & Extension Center @ Torrington, WY. 4104 ft MSL; sandy loam soil; overhead irrigation
Plot Design	RCBD with 4 replications; Treatment plots were 4 rows (30-inch centers) X 20 ft with a 5 ft in-row buffer. All treatments were made to, and all data were collected from, the center two rows.
Plot Management	**Planting Date**: 31 May. **Variety**: Bill Z. **Fertilizer**: 100 lbs N, 40 lbs P_2O_5 **Herbicide:** Sonalan + Eptam (2 pt + 4.5 pt product/A, PRE) 29 May. **Insecticide:** Asana (5 fl oz product for Mexican bean beetle) 19 July.
Disease Development	**Natural**: Rust pustules were not observed in the plot area. Beans in the plot area were infected with bacterial bean blight.
Treatment Applications	Fungicide applications were made on 15 August. Fungicide treatments were applied with the aid of a portable (CO_2) sprayer in a total volume of 43 gal/A @ 30 psi boom pressure (four #8004 flat fan nozzles spaced @ 20 inches).
Disease Ratings	Ten terminal leaflets were randomly selected from the middle canopy of each treatment plot on 15, 21, and 28 August. The number of pustules per leaflet underside was counted and the treatment plot average was calculated. Not all data is shown in Table 1. Plots were visually rated for percent foliar necrosis on 4 September.
Harvest	On 1 October, the center 10 ft X two rows for each plot were harvested by hand and then threshed with a small combine. Total yield was measured for each treatment plot plus a seed quality (size) rating was made by determining seed numbers per pound of seed.
Statistical Analysis	Data were analyzed by ANOVA and mean separations were done using Fisher's protected LSD (P#0.05).

Results and Discussion

Bean rust failed to develop in the plot area as well as in neighboring bean plots. Bacterial bean blight developed in the plot area causing significant foliar and pod necrosis. Treatments had no effect on the bean blight induced necrosis (Table 1, P=0.05). In the absence of rust and with no significant reduction in bacterial bean blight severity, fungicide treatments had no effect on yield or seed quality (P=0.05).

Table 1. The effects of foliar fungicide treatments on bean rust disease management (G.D. Franc et al., U of WY; 2001).

Treatment and Application Rate (lb a.i./ acre) [1]	Number of rust pustules per terminal leaflet	Plant necrosis (%) [2]	Seed yield and Quality	
	28 Aug	4 Sep	cwt/A	seeds/lb
1. Nontreated Control	0 a [3]	93.3 a	28.9 a	1484 a
2. Manex II (1.4)	0 a	88.0 a	26.6 a	1545 a
3. GX70001A (0.23)	0 a	89.7 a	28.0 a	1466 a
4. Equus ZN (1.8).	0 a	85.5 a	27.1 a	1449 a

[1] Fungicide application date: 15 August, 2001.

[2] Plant necrosis was primarily due to bacterial bean blight presence that developed from natural inoculum. Bean rust failed to develop in the plot and in neighboring fields.

[3] Treatment means followed by different letters differ significantly (Fisher-s protected LSD, P=0.05).

Research Project	**Foliar and Tuber Water-Rot Disease Management in Potato with Foliar Fungicide Programs, 2001**
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Tel: 307-766-2397 FAX: 766-5549 francg@uwyo.edu	
Field Plot Location	Torrington Research & Extension Center @ Torrington, WY. 4104 ft MSL; sandy loam soil; overhead irrigation
Plot Design	RCBD with 4 replications; plots were 4 rows (36-in row centers) X 20 ft; 5 ft in-row buffer. All treatments were made to, and all data were collected from, the center two rows.
Plot Management	**Planting Date**: 10 May. **Variety**: Atlantic. **Fertilizer**: 150 lb N + 50 lb P_2O_5 on 31 March. **Herbicide**: Eptam + Prowl (3 pt + 1.2 pt product) PRE on 17 May. **Insecticide**: Asana (4 fl oz product) on 20 June for Colorado potato beetle. **Harvest Date**: 21 September.
Disease Development	Early blight development was from natural inoculum and the first typical lesions were observed on 17 July. Late blight lesions were not observed during plot ratings.
Treatment Applications	Foliar treatments consisted of spray programs that began on 18 July. The actual application dates are indicated in the Tables. Fungicides were applied with the aid of a portable (CO_2) sprayer in a total volume of 43 gal/A @ 30 psi boom pressure (four #8004 flat fan nozzles spaced @ 20 inches).

Disease and other Treatment Ratings

Early blight disease severity was measured by calculating the average number of lesions per leaflet for leaves collected on 17, 24, 31 July, and 7, 14, 21, and 28 August. Six leaves were randomly selected from each treatment plot (two leaves each from the top, middle, and bottom third of the canopy) and the number of early blight lesions, on up to seven leaflets from each leaf, was counted. Data from the last four data collection dates are summarized in Table 1. Lesion-count data from all dates were used to calculate an area under the disease progress curve (AUDPC) rating for each treatment program. The AUDPC is a measure of season long disease severity for each treatment. Plots were visually rated using the Horsfall-Barratt scale (0-11) to estimate the percentage of foliar necrosis (combined effects of disease and senescence) on 28 August, and 4, 11 September.

Stimplex: Potential growth regulator effects were measured several times during the growing season. Treatments compared with the Stimplex treatment (Stimplex = treatment 27; season-long Echo ZN with two applications of Stimplex) were the nontreated check (treatment 1) and a season-long program of Echo ZN (treatment 9). Plant vigor ratings (check = 7) were made on 17 July, and 1, 15 September. The average plant height was measured (based on 3 plants measured per plot) for these treatments on 17 July, and 1 September. Early blight severity data, foliar necrosis and tuber yield and size distribution (grade) were measured as described for all other treatments in the tables.

KQ667: The potential for KQ667 to suppress *Alternaria alternata* was tested by recovering Alternaria fungi from typical early blight lesions. On 28 August, 20 leaves were collected from treatments 5 (Quadris), 9 (Echo ZN), 28 (KQ667 1.03), and 29 (KQ667 1.38). Fungi associated with typical early blight lesions were cultured and categorized according to spore morphology. Sixty typical early blight lesions from the 20 leaves were dissected, surface disinfested and plated onto water agar. After 7 days of growth at room temperature, each isolation attempt was categorized as either *A. solani* (large alternaria spores with beak present, not chained), *A. alternata*-like (presumptive identification based on small alternaria spores present, chained), both types (*A. solani* and *A. alternata*-like spores present), or none (no alternaria spores produced).

Harvest	Two rows X 10 ft were dug on 21 September, and then sorted and weighed by grade.
Tuber Bioassays for Post Harvest Pink Rot and Late Blight Suppression by Foliar Flouronil and Phostrol Applications	Tuber bioassays were conducted for susceptibility to the pink rot fungus (*Phytophthora erythroseptica*) by Gary Secor, NDSU, Fargo, ND. Fifty tubers each from treatments 23, 24, 25, and 26 were inoculated with pink rot and the disease incidence was measured. The procedure used was their standard protocol. Tuber bioassays also were conducted for susceptibility to the late blight fungus (*Phytophthora infestans*) at the University of Wyoming. Forty whole tubers each from treatments 23, 24, 25, and 26, were dip inoculated with either US1 or US8 late blight inoculum. Inoculum consisted of sporangial suspensions prepared at concentrations of 2,000 (2K) and 10,000 (10K) sporangia per ml. Sporangial suspensions were cold-shocked to induce zoospore formation prior to dip-inoculation. As a check of isolate virulence, ten tubers for each treatment were wounded by a Apin-frog@ prior to dip-inoculation with either US1 or US8 at the 2K inoculum dose. Tuber wounding provided an avenue for infection that bypassed natural and chemical tuber defenses associated with the periderm. After a two week incubation period at room temperature and high relative humidity, tubers were rated for late blight infection (incidence) and the percentage of the tuber volume affected (severity) was estimated. Additionally, tubers were rated for soft rot decay incidence and severity. Soft-rot was rated because infection by the late blight fungus often predisposes tubers to decay from soft-rot bacteria.
Statistical Analysis	ANOVA with four replications. Mean separations were done using Fisher's protected LSD (P#0.05).

Results and Discussion

Early blight disease development was moderate during 2001, and late blight was not detected in the plots. A moderate Psyllid infestation may have effected yields and tuber size. Phytotoxicity was not observed for any of the fungicide programs and plots appeared to senesce normally.

By 7 August and throughout the remainder of the season, most fungicide programs significantly reduced the average number of early blight lesions per leaflet compared to the nontreated check (Table 1, P#0.05). The exception was the Flouronil program (treatment 23) for which lesion counts late in the season (21 and 28 August) did not differ from the nontreated check (P=0.05). All treatments significantly reduced the AUDPC when compared to the nontreated check (P#0.05). All fungicide programs except Flouronil significantly reduced foliar necrosis on 28 August and 4 September compared to the nontreated check (P#0.05). By 11 September all

treatments had foliar necrosis greater than 83% and differences from the nontreated check were infrequent.
Application of the growth regulator Stimplex had no significant effect on plant height compared to the nontreated check or Echo ZN alone (P=0.05). Plant vigor was not significantly different between Stimplex + Echo ZN and Echo ZN alone (P=0.05). There were no significant effects of Stimplex treatment on tuber yield and size distribution or grade (Table 4: P=0.05).

KQ667 effects on recovery of Alternaria fungi from lesions are summarized in Table 3. Nontreated checks were not assayed because leaves were all dead at the time of collection. Results revealed that treatment 5 (Quadris applied weekly) had an increased recovery of *A. alternata* compared to weekly Echo ZN and KQ667 treatments. The effect of KQ667 on fungus recovery from early blight lesions was similar to the effects of Echo ZN on alternaria recovery.

Treatment effects on yield and quality are shown in Table 4. Yields in general were poor and tuber sizes were reduced compared to prior years, probably due to moderate Psyllid infestations. Total yield was not significantly affected by treatment (P=0.05). Significant treatment differences in tuber quality were found only with the grade B tubers (P#0.05).

Flouronil (treatment 23) was only applied twice during the early part of the season (on 18 July and 1 August) and was included as a standard treatment to target tuber water-rots (pink rot and/or late blight) and was not intended to provide season-long early blight management. Season-long early blight management would normally require additional applications of fungicide to protect foliage from foliar pathogens, as shown by the data in Table 1. However, the efficacy of Flouronil and phostrol for use as water-rot management tools were tested via bioassays of harvested tubers.

Inoculations with the pink rot fungus resulted in a low incidence of infection and there were no significant differences among treatments for pink rot suppression (Table 5, P=0.05). Inoculation with the late blight fungus resulted in greater levels of disease expression compared to pink rot. Inoculation following tuber-wounding revealed 67% to 100% of the tubers expressed late blight symptoms (averaged over the two isolates) and that the isolates used in the bioassay were virulent. When tubers were not wounded prior to inoculation, the incidence of disease ranged from 7% to 11%. However, there were no significant differences among the four fungicide treatments tested (P=0.05). Therefore, the phostrol treatments were statistically equivalent to the Flouranil treatment based on tuber bioassays for pink rot and late blight suppression (P=0.05).

Table 1. Fungicide program effects on early blight disease progression (G.D. Franc et al., U of WY; 2001).

Treatment and Application Rate (lb a.i./ acre)	Application dates [1]	Early blight lesions per leaflet				AUDPC [2]
		7 Aug	14 Aug	21 Aug	28 Aug	
1. Nontreated Check		4.40 a	5.56 a	12.61 a	12.61 a	205 a
2. BAS 500 (0.15)	A-G	0.63 cd	0.28 cd	0.99 e	1.04 ef	20 f-i
3. BAS 510 (0.15)	A-G	0.51 cd	0.17 cd	0.60 e	0.62 f	12 hi
4. BAS 500 (0.15)	A, C, E, G	0.62 cd	0.18 cd	1.24 de	0.71 f	18 ghi
4. Bravo ZN (1.12)	B, D, F					
5. Quadris (0.1)	A-G	0.27 d	0.17 cd	1.25 de	0.34 f	15 ghi
6. Dithane DF NT (1.13)	A, B, C, G	1.10 bcd	1.55 b	5.81 b	4.04 bcd	75 cd
6. Gavel (1.5)	D, E, F					
7. Gavel (1.5)	B, D, E, F	0.53 cd	0.77 bcd	0.97 e	0.37 f	19 f-i
7. Quadris (0.1)	A, C, G					
8. Bravo ZN (1.12)	B, D, E, F	0.70 cd	0.29 cd	0.60 e	0.74 f	15 ghi
8. Quadris (0.1)	A, C, G					
9. Echo ZN (1.12)	A-G	1.10 bcd	0.75 bcd	2.27 cde	1.97 def	39 e-i
10. Echo ZN + Curzate (1.12 + 0.21)	A-G	0.90 bcd	0.57 bcd	3.09 b-e	2.03 def	41 e-h
11. Echo ZN (1.12)	A, C, E, G	0.57 cd	0.14 d	0.79 e	0.58 f	14 ghi
11. Echo ZN + Quadris (0.78 + 0.1)	B, D, F					
12. Quadris (0.1)	A, C, G	0.62 cd	0.57 bcd	0.86 e	0.63 f	17 ghi
12. Equus ZN (0.78)	B, D, E, F					
13. Quadris (0.1)	A, C, G	0.26 d	0.21 cd	0.49 e	0.54 f	9 i
13. Equus DF (1.16)	B, D, E, F					
14. Manex II (1.5)	A-G	0.15 d	0.30 cd	1.73 de	0.23 f	18 ghi
14. Quadris (0.1)	B, C					
14. Super Tin (2 oz)	D, E, F					
15. Manzate (1.125)	A, C, E, G	0.95 bcd	0.18 cd	1.81 de	1.21 ef	27 f-i
15. Equus ZN + Super Tin (0.78 + 2 oz)	B, D, F					
16. Curzate + Dithane DF NT (2 oz + 1.125). . .	A-G	1.48 bc	1.45 b	5.39 bc	6.37 b	83 c
17. Curzate + Bravo Weather Stik (2 oz + 1.125).	A-G	1.19 bcd	0.85 bcd	1.59 de	3.41 cde	39 e-i
18. BAS 500 (0.15)	A, C, E, G	0.33 cd	0.19 cd	1.28 de	0.83 f	17 ghi
18. Ranman + Silwet (0.5 + 0.1% v:v)	B, D, F					

Treatment and Application Rate (lb a.i./ acre)	Application dates [1]	Early blight lesions per leaflet				AUDPC [2]
		7 Aug	14 Aug	21 Aug	28 Aug	
19. BAS 500 (0.2)	A, C, E, G	0.19 d	0.29 cd	0.47 e	0.43 f	9 i
19. Ranman + Silwet (0.7 + 0.1% v:v)	B, D, F					
20. Ranman + Silwet + Super Tin (0.7 + 0.1% v:v + 2 oz)	A-G	1.13 bcd	0.70 bcd	2.44 cde	2.18 def	39 e-i
21. Ranman + Silwet + BAS 500 (0.7 + 0.1% v:v + 0.15)	A-G	0.18 d	0.30 cd	0.51 e	0.39 f	10 i
22. Echo ZN + Champ (1.125 + 1.15)	A, C, E, G	0.73 cd	0.52 bcd	3.26 b-e	1.50 def	38 e-i
22. AgriTin + Dithane DF NT (2 oz + 1.5)	B, D, F					
23. Flouronil (2 lb product)	A, C	2.04 b	1.55 b	11.23 a	11.23 a	144 b
24. Echo ZN (1.125)	A-G	0.57 cd	0.81 bcd	2.84 b-e	1.85 def	37 e-i
24. Phostrol (2 pt product)	A-F					
25. Echo ZN (1.125)	A-G	0.83 cd	0.30 cd	4.38 bcd	5.29 bc	58 cde
25. Phostrol (6 pt product)	E, G					
26. Echo ZN (1.125)	A-G	0.88 bcd	0.75 bcd	1.23 de	2.26 def	30 e-i
26. Phostrol (4 pt product)	G					
27. Echo ZN (1.125)	A-G	0.35 cd	0.52 bcd	2.70 b-e	3.53 cde	38 e-i
27. Stimplex (2.5 pt)	A, C					
28. KQ667 (1.03)	A-G	0.80 cd	1.46 b	2.79 b-e	2.26 def	45 d-g
29. KQ667 (1.38)	A-G	1.46 bd	1.29 bc	3.31 b-e	1.76 def	50 def

[1] Application dates: A=7/18, B=7/25, C=8/1, D=8/8, E=8/15, F=8/22, and G=8/29.

[2] Area under the disease progress curve for data collected 17 Jul through 28 Aug.

[3] Treatment means followed by different letters differ significantly (Fisher-s protected LSD, P#0.05).

Table 2. Fungicide program effects on the progression of foliar necrosis (G.D. Franc et al., U of WY; 2001).

Treatment and Application Rate (lb a.i./ acre)	Application dates [1]	% Foliar Necrosis [2]		
		28 Aug	4 Sep	11 Sep
1. Nontreated Check		98.5 a [3]	98.5 a	100.0 a
2. BAS 500 (0.15)	A-G	38.1 efg	59.5 efg	97.0 a-d
3. BAS 510 (0.15)	A-G	38.1 efg	55.0 fg	92.8 b-f
4. BAS 500 (0.15) 4. Bravo ZN (1.12)	A, C, E, G B, D, F	23.5 g	50.0 g	83.0 f
5. Quadris (0.1)	A-G	31.0 efg	55.0 fg	95.3 a-f
6. Dithane DF NT (1.13) 6. Gavel (1.5)	A, B, C, G D, E, F	59.5 bcd	85.5 bcd	99.0 ab
7. Gavel (1.5) 7. Quadris (0.1)	B, D, E, F A, C, G	27.3 fg	55.0 fg	88.0 def
8. Bravo ZN (1.12) 8. Quadris (0.1)	B, D, E, F A, C, G	38.1 efg	45.0 g	85.5 ef
9. Echo ZN (1.12)	A-G	45.0 def	79.8 b-e	96.0 a-e
10. Echo ZN + Curzate (1.12 + 0.21)	A-G	50.0 cde	76.5 c-f	97.0 a-d
11. Echo ZN (1.12) 11. Echo ZN + Quadris (0.78 + 0.1)	A, C, E, G B, D, F	38.1 efg	64.0 efg	89.8 c-f
12. Quadris (0.1) 12. Equus ZN (0.78)	A, C, G B, D, E, F	31.0 efg	59.5 efg	85.5 ef
13. Quadris (0.1) 13. Equus DF (1.16)	A, C, G B, D, E, F	23.5 g	55.0 fg	88.0 def
14. Manex II (1.5) 14. Quadris (0.1) 14. Super Tin (2 oz)	A-G B, C D, E, F	31.0 efg	59.5 efg	95.3 a-f
15. Manzate (1.125) 15. Equus ZN + Super Tin (0.78 + 2 oz)	A, C, E, G B, D, F	40.5 d-g	59.5 efg	92.8 b-f
16. Curzate + Dithane DF NT (2 oz + 1.125)	A-G	72.8 b	91.5 b	98.0 abc
17. Curzate + Bravo Weather Stik (2 oz + 1.125)	A-G	69.0 bc	88.0 bc	97.0 a-d
18. BAS 500 (0.15) 18. Ranman + Silwet (0.5 + 0.1% v:v)	A, C, E, G B, D, F	50.0 cde	79.8 b-e	95.3 a-f

Treatment and Application Rate (lb a.i./ acre)	Application dates [1]	% Foliar Necrosis [2]		
		28 Aug	4 Sep	11 Sep

19. BAS 500 (0.2) 19. Ranman + Silwet (0.7 + 0.1% v:v)	A, C, E, G B, D, F	40.5 d-g	76.5 c-f	94.0 b-f
20. Ranman + Silwet + Super Tin (0.7 + 0.1% v:v + 2 oz)	A-G	40.5 d-g	79.8 b-e	96.0 a-e
21. Ranman + Silwet + BAS 500 (0.7 + 0.1% v:v + 0.15)	A-G	40.5 d-g	69.0 d-g	97.0 a-d
22. Echo ZN + Champ (1.125 + 1.15) 22. AgriTin + Dithane DF NT (2 oz + 1.5)	A, C, E, G B, D, F	45.0 def	69.0 d-g	89.8 c-f
23. Flouronil (2 lb product)	A, C	98.0 a	98.5 a	100.0 a
24. Echo ZN (1.125) 24. Phostrol (2 pt product)	A-G A-F	38.3 efg	64.0 efg	91.5 c-f
25. Echo ZN (1.125) 25. Phostrol (6 pt product)	A-G E, G	45.0 def	76.5 c-f	98.0 abc
26. Echo ZN (1.125) 26. Phostrol (4 pt product)	A-G G	40.5 d-g	69.0 d-g	94.0 b-f
27. Echo ZN (1.125) 27. Stimplex (2.5 pt)	A-G A, C	40.5 d-g	64.0 efg	96.0 a-e
28. KQ667 (1.03)	A-G	38.1 efg	52.5 fg	92.8 b-f
29. KQ667 (1.38)	A-G	31.0 efg	59.5 efg	95.3 a-f

[1] Application dates: A=7/18, B=7/25, C=8/1, D=8/8, E=8/15, F=8/22, and G=8/29.

[2] Data presented were converted to percentages from Horsfall-Barratt scale (0-11) data.

[3] Treatment means followed by different letters differ significantly (Fisher-s protected LSD, P#0.05).

Table 3. The effects of selected fungicide treatments on fungus recovery from early blight lesions collected 28 August, 2001 (G.D. Franc et al., U of WY; 2001).

Treatment and Application Rate (lb a.i./ acre)	Application dates [1]	# lesions attempted	Number and (%) of fungal species recovered [2]			
			A. solani	*A. alternata*	Both types	None
5. Quadris (0.1)	A-G	59	9 (15)	18 (31)	6 (10)	26 (44)
9. Echo ZN (1.12).....	A-G	60	13 (22)	10 (17)	25 (42)	12 (20)
28. KQ667 (1.03)	A-G	60	13 (22)	10 (17)	20 (33)	17 (28)
29. KQ667 (1.38)	A-G	60	12 (20)	13 (22)	23 (38)	12 (20)

[1] Application dates: A=7/18, B=7/25, C=8/1, D=8/8, E=8/15, F=8/22, and G=8/29.

[2] Individual Aearly blight@ lesions were surface disinfected and plated on water agar. Alternaria sporulation was observed after 7 days growth and rated morphologically. Large-spored fungal growth typical of the early blight fungus was assigned to *Alternaria solani* and small-spored chains were characterized as *A. alternata*-like in appearance with no additional efforts for classification.

Table 4. The effects of foliar fungicide programs on potato yield and grade (G.D. Franc et al., U of WY; 2001).

Treatment and Application Rate (lb a.i./ acre)	Application dates [1]	Cwt/A				
		US#1	US#2	Grade B	Cull	Total
1. Nontreated Check		156 a [2]	13 a	53 def	0.7 a	224 a
2. BAS 500 (0.15)	A-G	149 a	22 a	64 a-e	0.0 a	235 a
3. BAS 510 (0.15)	A-G	189 a	12 a	56 c-f	0.0 a	258 a
4. BAS 500 (0.15) 4. Bravo ZN (1.12)	A, C, E, G B, D, F	177 a	14 a	62 a-e	0.4 a	254 a
5. Quadris (0.1)	A-G	153 a	6 a	60 a-e	1.3 a	220 a
6. Dithane DF NT (1.13) 6. Gavel (1.5)	A, B, C, G D, E, F	144 a	16 a	62 a-e	0.0 a	223 a
7. Gavel (1.5) 7. Quadris (0.1)	B, D, E, F A, C, G	134 a	17 a	72 abc	1.8 a	225 a
8. Bravo ZN (1.12) 8. Quadris (0.1)	B, D, E, F A, C, G	166 a	15 a	63 a-e	1.1 a	245 a
9. Echo ZN (1.12)	A-G	127 a	5 a	72 abc	2.0 a	207 a
10. Echo ZN + Curzate (1.12 + 0.21)	A-G	174 a	17 a	62 a-f	0.0 a	253 a
11. Echo ZN (1.12) 11. Echo ZN + Quadris (0.78 + 0.1)	A, C, E, G B, D, F	124 a	15 a	64 a-e	0.0 a	203 a
12. Quadris (0.1) 12. Equus ZN (0.78)	A, C, G B, D, E, F	119 a	18 a	76 ab	0.6 a	214 a
13. Quadris (0.1) 13. Equus DF (1.16)	A, C, G B, D, E, F	148 a	22 a	66 a-e	0.7 a	236 a
14. Manex II (1.5) 14. Quadris (0.1) 14. Super Tin (2 oz)	A-G B, C D, E, F	192 a	18 a	63 a-e	0.0 a	272 a
15. Manzate (1.125) 15. Equus ZN + Super Tin (0.78 + 2 oz)	A, C, E, G B, D, F	126 a	13 a	67 a-d	1.1 a	208 a
16. Curzate + Dithane DF NT (2 oz +1.125)	A-G	115 a	17 a	64 a-e	0.0 a	196 a
17. Curzate + Bravo Weather Stik (2 oz + 1.125)	A-G	105 a	16 a	49 ef	0.0 a	170 a
18. BAS 500 (0.15) 18. Ranman + Silwet (0.5 + 0.1% v:v)	A, C, E, G B, D, F	149 a	18 a	58 b-e	0.0 a	226 a

Treatment and Application Rate	Application	Cwt/A

(lb a.i./ acre)	dates [1]	US#1	US#2	Grade B	Cull	Total
19. BAS 500 (0.2) 19. Ranman + Silwet (0.7 + 0.1% v:v)	A, C, E, G B, D, F	112 a	17 a	77 a	0.0 a	206 a
20. Ranman + Silwet + Super Tin (0.7 + 0.1% v:v + 2 oz)	A-G	187 a	11 a	62 a-e	0.0 a	260 a
21. Ranman + Silwet + BAS 500 (0.7 + 0.1% v:v + 0.15)	A-G	151 a	20 a	48 ef	0.0 a	218 a
22. Echo ZN + Champ (1.125 + 1.15) 22. AgriTin + Dithane DF NT (2 oz + 1.5)	A, C, E, G B, D, F	122 a	16 a	49 ef	1.5 a	189 a
23. Flouronil (2 lb product)	A, C	140 a	7 a	48 ef	0.0 a	195 a
24. Echo ZN (1.125) 24. Phostrol (2 pt product)	A-G A-F	167 a	13 a	59 b-e	0.0 a	239 a
25. Echo ZN (1.125) 25. Phostrol (6 pt product)	A-G E, G	153 a	10 a	45 f	0.0 a	209 a
26. Echo ZN (1.125) 26. Phostrol (4 pt product)	A-G G	155 a	16 a	51 def	0.0 a	222 a
27. Echo ZN (1.125) 27. Stimplex (2.5 pt)	A-G A, C	158 a	7 a	64 a-e	0.3 a	230 a
28. KQ667 (1.03)	A-G	158 a	14 a	58 b-e	0.3 a	231 a
29. KQ667 (1.38)	A-G	162 a	21 a	61 a-e	0.0 a	244 a

[1] Application dates: A=7/18, B=7/25, C=8/1, D=8/8, E=8/15, F=8/22, and G=8/29.

[2] Treatment means followed by different letters differ significantly (Fisher=s protected LSD, P#0.05).

Table 5. The effects of selected fungicide treatments on tuber protection against pink rot, and late blight fungi following inoculation (G.D. Franc et al., U of WY; 2001).

Treatment and Application Rate (lb a.i./ acre)	Application dates [1]	Pink rot infection [2] incidence (%)	Soft rot infection [3]		Late blight infection [4]					
			Incidence (%)	Severity : volume rotted (%)	Incidence (%)			Severity: volume rotted (%)		
					US1	US8	ave	US1	US8	ave
Inoculation of non-wounded tubers										
23. Flouronil (2 lb product)	A, C	1.3 a	3.1 a	0.7 a	6.3 a	10.0 a	8.1 a	0.1 a	0.3 a	0.2 a
24. Echo ZN (1.125)..... 24. Phostrol (2 pt product)	A-G A-F	0.0 a	1.9 a	0.3 a	7.5 a	6.3 a	6.9 a	0.1 a	0.2 a	0.1 a
25. Echo ZN (1.125)..... 25. Phostrol (6 pt product)	A-G E, G	0.6 a	1.9 a	0.9 a	8.8 a	12.5 a	10.6 a	0.2 a	0.4 a	0.3 a
26. Echo ZN (1.125)..... 26. Phostrol (4 pt product)	A-G G	1.3 a	5.0 a	2.1 a	10.0 a	7.5 a	8.8 a	0.2 a	0.3 a	0.2 a
Inoculation of wounded tubers										
23. Flouronil (2 lb product)	A, C	NA	14.6 a	2.0 a	100.0 a	83.3 a	91.6 a	1.1 a	2.9 a	2.0 a
24. Echo ZN (1.125)..... 24. Phostrol (2 pt product)	A-G A-F	NA	16.7 a	3.9 a	100.0 a	100.0 a	100.0 a	1.6 a	4.9 a	3.3 a
25. Echo ZN (1.125)..... 25. Phostrol (6 pt product)	A-G E, G	NA	12.5 a	0.5 a	41.8 a	91.8 a	66.8 a	0.4 a	2.5 a	1.5 a
26. Echo ZN (1.125)..... 26. Phostrol (4 pt product)	A-G G	NA	16.7 a	7.0 a	100.0 a	75.0 a	87.5 a	1.0 a	1.9 a	1.5 a

[1] Application dates: A=7/18, B=7/25, C=8/1, D=8/8, E=8/15, F=8/22, and G=8/29.

[2] Pink rot (*Phytophthora erythroseptica*) bioassays were conducted by G. Secor, N. Dakota State University, Fargo, ND.

[3] Soft rot was evaluated separately during late blight evaluations. Values presented were averaged over tubers inoculated with US1and US8 (*P. infestans*) concentrations of 2,000 or 10,000 sporangia per ml, following cold-shocking.

[4] Values presented were averaged over the 2K and 10K spores per ml concentrations.

Research Project	**Effect of Quadris Placement for Rhizoctonia Root and Crown Rot Management in Sugar Beet, 2001**
Research Team Tel: 307-766-2397 FAX: 307-766-5549 francg@uwyo.edu	G.D. Franc, W.L. Stump and S.C. Briere University of Wyoming, Dept. of Plant Sciences P.O. Box 3354 (16th & Gibbon Streets) Laramie, WY 82071-3354
Field Plot Location	Torrington Research & Extension Center @ Torrington, WY. 4104 ft MSL; sandy loam soil; overhead irrigation
Plot Design	RCBD with 4 replications; plots were 4 rows (30-in row centers) X 20 ft; 5 ft in-row buffer between plots. Quadris treatments were made to, and all data were collected from, the center two rows of each plot. Rhizoctonia-inoculated and non-inoculated (natural inoculum) rows were paired within each plot.
Plot Management	**Planting Date**: 20 April. **Variety**: Monohikari. **Fertilizer**: 150 lbs N + 50 lbs P_2O_5 **Herbicide**: Post emergence applications of Progress + Upbeet + Stinger (17 fl oz + 0.5 oz + 4 fl oz product/A) on 16 May, Progress + Upbeet + Select (20 fl oz + 0.5 oz + 8 fl oz product/A) on 24 May, and Progress (20 fl oz + 8 fl oz product/A) + Select on 4 June. **Insecticide:** Asana (8 fl oz product/A) for cabbage looper management was made on 11 June.
Disease Development	All treatment plots were inoculated on 13 June, immediately following band applications of Quadris and cultivation. Rhizoctonia inoculum (0.8 g) was applied to the crown of all plants within a randomly selected center row of each treatment plot. After inoculation, plots were watered three times within 72 hr to favor infection. Inoculum was prepared by culturing several *Rhizoctonia solani* AG2-2 isolates on winter wheat, followed by air-drying and grinding. Rhizoctonia development in the non-inoculated center row of each treatment plot relied upon naturally occurring inoculum already present in the soil. Sugar beets were in the 10-12 leaf stage at the time of inoculation.
Treatment Applications	**In-furrow treatments** were applied on 20 April to open furrows. Fungicide was applied with the aid of a backpack sprayer in a total spray volume of 22 gal/A at 50 psi boom pressure. The boom was equipped with a single #8002 flat fan nozzle. The fungicide was incorporated with a hand-held hoe and then seed was placed with a commercial planter into the treated soil. **Band applications** (7-inch width) were made on 13 June with the aid of a backpack sprayer in a total spray volume of 22 gal/A at 50 psi boom

	pressure. The boom was equipped with a single #8002 flat fan nozzle. Sugar beets were in the 10-12 leaf stage at the time of application.
Data Collection	Stand counts (per 10 ft) were taken on 31 May and 4 July for the inoculated and non-inoculated rows, separately.
Disease Ratings	All disease ratings were taken on the inoculated and non-inoculated rows separately. Rhizoctonia incidence and severity ratings were based on five plants/plot (destructive sampling) collected on 3 July. The number of roots with decay consistent with Rhizoctonia and the percentage of surface-area decayed was estimated for measurements of disease incidence and severity, respectively. Disease incidence also was rated (per 20 ft) on 10 and 24 July, and on 8 August. Incidence was determined by counting the number of plants wilted and/or dead following infection of crowns by Rhizoctonia. At harvest on 24 September, Rhizoctonia severity and incidence was rated for 5 ft of row.
Harvest	The inoculated and non-inoculated rows (5 ft) were dug separately on 24 September. The percentage of total sucrose and nitrate levels were determined by Holly Sugar=s laboratory.
Statistical Analysis	ANOVA with four replications. Mean separations were done using Fisher's protected LSD (P#0.05).

Results and Discussion

In-furrow and band applications of Quadris had no significant effect on seedling emergence and stand establishment (Table 1: P= 0.05). Inoculation of beet crowns on 13 June resulted in substantial root and crown rot development. Effects of treatment on disease severity were not significant when measured on 3 July (P#0.05). However, data for inoculated rows revealed that Quadris banded applications significantly suppressed disease incidence by 3 July compared with the in-furrow treatments and the nontreated check (Table 1). The effect of banded treatments on disease suppression persisted for the remainder of the disease rating dates (Table 2: P#0.05).

Banded applications of Quadris significantly reduced disease incidence and severity at harvest compared to the nontreated control (Table 3: P#0.05). The high rate Quadris (0.15 oz ai/1000 ft) in-furrow treatment also significantly reduced disease incidence (%) and severity compared to the nontreated control (P#0.05). Banded applications resulted in greater numbers of beet roots present at harvest and these treatments also had improved yields and sucrose percentages compared to the nontreated control (Table 4: P#0.05). In-furrow applications were not different from the nontreated control with the exception of the high Quadris in-furrow rate (0.15 oz ai/1000 ft) which had improved sucrose content compared to the nontreated control (P#0.05).

Results revealed that under heavy disease pressure, banded Quadris applications made at the time of inoculation significantly reduced losses associated with Rhizoctonia crown rot (P#0.05). There

were no differences detected between the two banded rates or when banded and in-furrow applications were combined (P=0.05). In the absence of significant early season Rhizoctonia disease pressure affecting stand establishment and seedling disease, results revealed that Quadris in-furrow applications are too early to offer much protection to plants from crown infection that occurs later in the growing season. Most crown rot is initiated by tillage operations that introduce contaminated soil onto the crowns of plants.

Table 1. Effects of Quadris placement on sugar beet stand establishment and early season Rhizoctonia disease development (G.D. Franc et. al., U of WY; 2001).

Treatment	Timing and Application Rate (a.i.) [1]	Stand counts (per 10 row ft)		Rhizoctonia incidence and severity: 3 Jul [2]	
		31 May	4 Jul	Incidence: # of roots rotted	Severity: surface area rotted (%)
1. Nontreated Control		22.8 a [3]	23.5 a	0.6 a	0.2 a
2. Quadris	in-furrow (0.1oz / 1000 ft)	23.8 a	24.5 a	0.6 a	0.1 a
3. Quadris	in-furrow (0.15 oz / 1000 ft)	26.5 a	28.3 a	0.8 a	0.1 a
4. Quadris	banded (0.1oz / 1000 ft)	18.8 a	22.0 a	0.0 b	0.0 a
5. Quadris	banded (0.15 oz / 1000 ft)	21.0 a	22.0 a	0.1 b	0.0 a
6. Quadris 6. Quadris	in-furrow (0.1oz / 1000 ft) banded (0.1oz / 1000 ft)	23.3 a	23.0 a	0.1 b	0.1 a

[1] In-furrow fungicide applications were made immediately prior to planting on 20 April. Banded applications were made on 13 June when beets were in the 10-12 leaf stage and then plants were cultivated. Immediately following band applications and cultivation, plants (one paired-row per plot) were inoculated with Rhizoctonia inoculum applied to the crown of each plant.

[2] Data are from a five-root subsample collected from inoculated rows. Disease incidence data represent the number of beet roots with visible decay consistent with Rhizoctonia symptoms. Severity data represent the percentage of the root surface-area decayed by Rhizoctonia and were converted from Horsfall-Barratt ratings (0-11).

[3] Treatment means followed by different letters differ significantly (Fisher-s protected LSD, P=0.05).

Table 2. Effects of Quadris placement treatments on Rhizoctonia root and crown rot development (G.D. Franc et. al., U of WY; 2001).

Treatment	Timing and Application Rate (a.i.) [1]	Number of beet plants with crown rot symptoms (disease incidence) per 20 row ft [2]					
		10 Jul		24 Jul		8 Aug	
		I	N	I	N	I	N
1. Nontreated Control		10.3 a [3]	0.0 a	24.8 a	0.0 a	28.3 a	0.5 a
2. Quadris.....	in-furrow (0.1oz / 1000 ft)	15.3 a	0.0 a	31.3 a	0.0 a	33.0 a	0.0 a
3. Quadris.....	in-furrow (0.15 oz / 1000 ft)	8.5 a	0.0 a	32.0 a	0.0 a	34.8 a	0.8 a
4. Quadris.....	banded (0.1oz / 1000 ft)	0.0 b	0.0 a	0.5 b	0.0 a	3.0 b	0.0 a
5. Quadris.....	banded (0.15 oz / 1000 ft)	0.0 b	0.0 a	0.3 b	0.0 a	2.0 b	0.3 a
6. Quadris.....	in-furrow (0.1oz / 1000 ft)	0.3 b	0.0 a	1.3 b	0.0 a	1.5 b	0.0 a
6. Quadris.....	banded (0.1oz / 1000 ft)						

[1] In-furrow fungicide applications were made immediately prior to planting on 20 April. Banded applications were made on 13 June when beets were in the 10-12 leaf stage and then plants were cultivated. Immediately following band applications and cultivation, plants (one paired-row per plot) were inoculated with Rhizoctonia inoculum applied to the crown of each plant.

[2] Ratings were taken on inoculated (I) and noninoculated (N) rows separately.

[3] Treatment means followed by different letters differ significantly (Fisher-s protected LSD, P=0.05).

Table 3. Effects of Quadris placement on Rhizoctonia root and crown rot disease incidence and severity at harvest (G.D. Franc et al., U of WY; 2001).

Treatment	Timing and application rate (oz a.i./1000ft) [1]	Rhizoctonia root and crown rot disease incidence and severity on 24 Sep [2]					
		Number of harvested beets with rot per 5 row ft		Percentage of harvested beets with rot per 5 row ft		Surface area of root affected by rot (%)	
		I	N	I	N	I	N
1. Nontreated Control.....		4.8 a [3]	0.0 a	100.0 a	0.0 a	70.0 a	0.0 a
2. Quadris.....	in-furrow (0.1oz / 1000 ft)	4.0 ab	0.0 a	96.9 a	0.0 a	66.3 a	0.0 a
3. Quadris.....	in-furrow (0.15 oz / 1000 ft)	4.8 a	0.0 a	76.0 b	0.0 a	29.3 b	0.0 a
4. Quadris.....	banded (0.1oz / 1000 ft)	0.8 c	0.0 a	8.0 c	0.0 a	2.5 b	0.0 a
5. Quadris.....	banded (0.15 oz / 1000 ft)	0.0 c	0.0 a	0.0 c	0.0 a	0.0 b	0.0 a
6. Quadris.....	in-furrow (0.1oz / 1000 ft)	1.5 bc	0.0 a	13.9 c	0.0 a	2.5 b	0.0 a
6. Quadris.....	banded (0.1oz / 1000 ft)						

[1] In-furrow fungicide applications were made immediately prior to planting on 20 April. Banded applications were made on 13 June when beets were in the 10-12 leaf stage and then plants were cultivated. Immediately following band applications and cultivation, plants (one paired-row per plot) were inoculated with Rhizoctonia inoculum applied to the crown of each plant.

[2] Ratings were taken on inoculated (I) and noninoculated (N) rows separately.

[3] Treatment means followed by different letters differ significantly (Fisher-s protected LSD, P=0.05).

Table 4. Effects of Quadris placement on sugar beet root yield and quality (G.D. Franc et. al., U of WY; 2001).

Treatment	Timing and application rate (oz a.i./1000ft) [1]	Beet yield and quality [2]							
		Number of beets per 5 row ft		Beet yield (tons/A)		Nitrate (ppm)		% total sucrose	
		I	N	I	N	I	N	I	N
1. Nontreated Control		4.8 c [3]	11.8 a	5.6 b	25.8 a	415 a	301 a	6.6 c	13.7 a
2. Quadris.....	in-furrow (0.1oz / 1000 ft)	4.3 c	10.3 a	1.0 b	25.1 a	370 a	327 a	7.7 c	14.0 a
3. Quadris.....	in-furrow (0.15 oz / 1000 ft)	6.3 bc	11.5 a	5.0 b	23.4 a	415 a	319 a	10.3 b	14.0 a
4. Quadris.....	banded (0.1oz / 1000 ft)	9.5 ab	14.5 a	22.3 a	27.7 a	313 a	340 a	14.2 a	14.4 a
5. Quadris.....	banded (0.15 oz / 1000 ft)	10.5 a	13.0 a	24.1 a	25.7 a	258 a	297 a	14.5 a	14.5 a
6. Quadris.....	in-furrow (0.1oz / 1000 ft)	9.0 ab	12.3 a	17.1 a	24.3 a	292 a	301 a	14.5 a	14.6 a
6. Quadris.....	banded (0.1oz / 1000 ft)								

[1] In-furrow fungicide applications were made immediately prior to planting on 20 April. Banded applications were made on 13 June when beets were in the 10-12 leaf stage and then plants were cultivated. Immediately following band applications and cultivation, plants (one paired-row per plot) were inoculated with Rhizoctonia inoculum applied to the crown of each plant.

[2] Ratings were taken on inoculated (I) and noninoculated (N) rows separately.

[3] Treatment means followed by different letters differ significantly (Fisher-s protected LSD, P=0.05).

Research Project	**Effects of Varying Flint Rates on Rhizoctonia Root and Crown Rot Development in Sugar Beet, 2001**
Research Team	G.D. Franc, W.L. Stump and S.C. Briere University of Wyoming, Dept. of Plant Sciences P.O. Box 3354 (16th & Gibbon Streets) Laramie, WY 82071-3354
Tel: 307-766-2397 FAX: 307-766-5549 francg@uwyo.edu	
Field Plot Location	Torrington Research & Extension Center @ Torrington, WY. 4104 ft MSL; sandy loam soil; overhead irrigation
Plot Design	RCBD with 4 replications; plots were 4 rows (30-in row centers) X 20 ft; 5 ft in-row buffer. Fungicide treatments were made to, and all data were collected from, the center two rows of each plot. Rhizoctonia-inoculated and non-inoculated (natural inoculum) rows were paired within each plot.
Plot Management	**Planting Date**: 20 April.. **Variety**: Monohikari. **Fertilizer**: 150 lbs N + 50 lbs P_2O_5 **Herbicide**: Post emergence applications of Progress + Upbeet + Stinger (17 fl oz + 0.5 oz + 4 fl oz product/A) on 16 May, Progress + Upbeet + Select (20 fl oz + 0.5 oz + 8 fl oz product/A) on 24 May, and Progress (20 fl oz + 8 fl oz product/A) + Select on 4 June. **Insecticide:** Asana (8 fl oz product/A) was applied for cabbage looper on 11 June.
Disease Development	On 13 June, immediately following the first fungicide applications and cultivation, Rhizoctonia inoculum was applied to each plant in one randomly-selected center row of each plot. Inoculum (0.25 tsp = 0.8 g) was applied to the crown of each plant. Beets were in the 8 to 12-leaf growth stage at the time of inoculation. After inoculation, plots were watered three times during a 72 hour time period to favor infection. Inoculum was prepared from cultures of *Rhizoctonia solani* AG2-2 isolates grown on winter wheat, followed by air-drying and grinding. Rhizoctonia development in the non-inoculated row relied upon naturally occurring inoculum.
Treatment Applications	Fungicide (7-inch band) applications were made on 13 June (immediately prior to inoculation), and 28 June (2 weeks later). Beets were in the 8-12 leaf stage at the initial application. Fungicide was applied with the aid of a backpack sprayer in a total spray volume of 22 gal/A at 50 psi boom pressure. The boom was equipped with a single #8002 flat fan nozzle.
Disease Ratings	Rhizoctonia crown rot **incidence** was rated separately for the inoculated

	and non-inoculated rows (20 ft) on 10 and 24 July, and on 8 and 21 August. Infected beets were those that had rapidly wilting leaves, darkened petioles and/or decayed crowns evident with necrotic leaves present. At harvest, both Rhizoctonia **severity** and **incidence** were rated from the 5 ft subsample dug to determine yields (see below). Disease severity was determined by visually estimating the volume of beet root affected by decay while disease incidence was a measure of the number of roots with any visible amount of decay.
Harvest	The inoculated and non-inoculated rows (5 ft) were dug separately on 24 September and total root yields were determined. The percentage of total sucrose and nitrate levels were determined by Holly Sugar=s laboratory.
Statistical Analysis	ANOVA with four replications. Mean separations were done using Fisher's protected LSD (P#0.05).

Results and Discussion

Following inoculation, Rhizoctonia root and crown rot development was evident in the plots by early July as rapidly wilting leaves with darkened petioles. However, disease incidence was relatively infrequent in the non-inoculated rows. Therefore, discussion of results will focus on data from the inoculated rows only.

By 10 July and throughout the remainder of the season all fungicide treatments suppressed Rhizoctonia root and crown rot development compared to the nontreated control (Table 1, P#0.05). By 8 August, separation among treatments was evident with Flint and Quadris treatments having significantly less disease incidence than BAS 500 (P#0.05). By 21 August, treatments with the two lower rates of Flint had disease incidence statistically equivalent to BAS 500 (P=0.05). Increasing rates of Flint decreased disease incidence. At harvest (Table 2), treatments had no effect on the number of beets with rot (P=0.05), however, many infected beets decayed in the ground prior to harvest and were not measured. All treatments reduced the percentage of harvested beets with rot (disease incidence) compared to the nontreated control (P#0.05). Measurements of disease severity (surface area of the root decayed) were variable, however, all fungicide treatments reduced disease severity.

All treatments increased the number of beets harvested and total beet root yield compared to the nontreated control (Table 3, P#0.05). Fungicide treatments had no significant effect on nitrate levels or the percentage of recoverable sucrose (P=0.05).

Results indicate that under conditions optimal for disease development, two properly-timed banded applications of a strobilurin fungicide significantly reduces losses from Rhizoctonia root and crown rot (P#0.05). Results also indicated that increased Flint rates provided additional disease suppression and that the range of Flint rates tested (0.11 to 0.27 oz a.i./1000 row ft) were comparable to the Quadris treatment (0.19 oz a.i./1000 row ft; P#0.05). Treatment with BAS 500 was less effective at season-long disease suppression than was Quadris applied at the same rate (0.19 oz a.i./1000 row ft; P#0.05).

Table 1. Effects of varying Flint rates on incidence of Rhizoctonia root and crown rot (Franc et al., U of WY; 2001).

Treatment	Timing and application rate (oz a.i./1000ft) [1]	Number of beet crowns with visible rot per 20 row ft [2]							
		10 Jul		24 Jul		8 Aug		21 Aug	
		I	N	I	N	I	N	I	N
1. Nontreated Control		15.5 a [3]	2.3 a	33.0 a	0.8 a	33.8 a	1.3 a	27.8 a	1.8 a
2. Flint.	at inoculation (0.11)	0.0 b	0.3 b	4.0 b	0.5 a	5.3 c	0.8 a	9.5 bc	1.0 a
. . 2. Flint.	2 weeks after inoculation (0.11)								
. .									
3. Flint.....	at inoculation (0.16)	0.3 b	0.0 b	1.3 b	0.0 a	5.0 c	0.5 a	8.3 bc	0.5 a
3. Flint.	2 weeks after inoculation (0.16)								
. .									
4. Flint.....	at inoculation (0.21)	0.0 b	0.0 b	1.8 b	0.0 a	2.8 c	0.3 a	4.0 c	0.3 a
4. Flint.	2 weeks after inoculation (0.21)								
. .									
5. Flint.....	at inoculation (0.27)	0.0 b	0.0 b	1.0 b	0.0 a	3.3 c	0.8 a	3.3 c	0.0 a
5. Flint.	2 weeks after inoculation (0.27)								
. .									
6. Quadris.....	at inoculation (0.19)	0.0 b	0.0 b	1.0 b	0.0 a	3.3 c	0.5 a	3.8 c	0.0 a
6. Quadris.	2 weeks after inoculation (0.19)								
. .									
7. BAS 500.	at inoculation (0.19)	1.5 b	0.0 b	5.8 b	0.0 a	14.0 b	0.0 a	15.8 b	0.0 a
. . 7. BAS 500.	2 weeks after inoculation (0.19)								
. .									

[1] All applications were made in a 7-inch banded spray in 22 gal/A @ 50 psi boom pressure. Plants in one randomly-selected paired-row per plot were inoculated with *Rhizoctonia solani* AG2-2 on 13 June, 2001 immediately after the first fungicide application and tillage.

[2] Ratings were taken on inoculated (I) and non-inoculated (N) rows separately.

[3] Treatment means followed by different letters differ significantly (Fisher-s protected LSD, P=0.05).

Table 2. Effects of varying Flint rates on Rhizoctonia root and crown rot measured disease at harvest (Franc et al., U of WY; 2001).

Treatment	Timing and application rate (oz a.i./1000ft) [1]	Rhizoctonia incidence (%) and severity at harvest on 24 Sep [2]					
		Number of harvested beets with rot per 5 row ft		Percentage of harvested beets with rot per 5 row ft		Surface area of root affected by rot (%)	
		I	N	I	N	I	N
1. Nontreated Control.....		3.8 a [3]	0.8 a	92.5 a	6.8 a	63.8 a	3.7 a
2. Flint.	at inoculation (0.11)	2.0 a	0.0 a	19.8 bcd	0.0 a	21.3 b	0.0 a
2. Flint.	2 weeks after inoculation (0.11)						
3. Flint.....	at inoculation (0.16)	4.5 a	0.5 a	35.9 bc	9.1 a	28.0 ab	2.5 a
3. Flint.	2 weeks after inoculation (0.16)						
4. Flint.....	at inoculation (0.21)	0.5 a	0.0 a	3.9 cd	0.0 a	2.5 b	0.0 a
4. Flint.	2 weeks after inoculation (0.21)						
5. Flint.....	at inoculation (0.27)	0.0 a	0.3 a	0.0 d	2.3 a	0.0 b	0.5 a
5. Flint.	2 weeks after inoculation (0.27)						
6. Quadris.....	at inoculation (0.19)	0.5 a	0.0 a	3.6 cd	0.0 a	2.0 b	0.0 a
6. Quadris.	2 weeks after inoculation (0.19)						
7. BAS 500.	at inoculation (0.19)	4.3 a	2.3 a	43.2 b	25.0 a	32.5 ab	0.0 a
7. BAS 500.	2 weeks after inoculation (0.19)						

[1] All applications were made in a 7-inch banded spray in 22 gal/A @ 50 psi boom pressure. Plants in one randomly-selected paired-row per plot were inoculated with *Rhizoctonia solani* AG2-2 on 13 June, 2001 immediately after the first fungicide application and tillage.

[2] Ratings were taken on inoculated (I) and non-inoculated (N) rows separately.

[3] Treatment means followed by different letters differ significantly (Fisher-s protected LSD, P=0.05).

Table 3. Effects of varying Flint rates on sugar beet root yield and quality (G.D. Franc et al., U of WY; 2001).

Treatment	Timing and application rate (oz a.i./1000ft) [1]	Beet yield and quality [2]							
		Number of beets per 5 row ft		Beet yield (tons/A)		Nitrate (ppm)		% total sucrose	
		I	N	I	N	I	N	I	N
1. Nontreated Control		4.5 b [3]	11.5 a	5.4 b	30.1 a	304 a	356 a	12.7 a	14.5 a
2. Flint.	at inoculation (0.11)	9.3 a	11.3 a	18.7 a	25.7 a	293 a	305 a	13.2 a	14.9 a
. .	2 weeks after inoculation (0.11)								
2. Flint.									
. .									
3. Flint.....	at inoculation (0.16)	12.8 a	12.8 a	27.0 a	26.0 a	351 a	352 a	13.5 a	14.4 a
3. Flint.	2 weeks after inoculation (0.16)								
. .									
4. Flint.....	at inoculation (0.21)	12.3 a	11.8 a	25.2 a	24.0 a	257 a	274 a	15.3 a	15.5 a
4. Flint.	2 weeks after inoculation (0.21)								
. .									
5. Flint.....	at inoculation (0.27)	10.5 a	10.8 a	25.6 a	28.5 a	313 a	267 a	15.3 a	15.1 a
5. Flint.	2 weeks after inoculation (0.27)								
. .									
6. Quadris.....	at inoculation (0.19)	11.8 a	11.5 a	23.7 a	27.2 a	287 a	312 a	15.0 a	14.8 a
6. Quadris.	2 weeks after inoculation (0.19)								
. .									
7. BAS 500.	at inoculation (0.19)	9.3 a	12.3 a	22.9 a	27.6 a	302 a	310 a	12.4 a	15.1 a
. .	2 weeks after inoculation (0.19)								
7. BAS 500.									
. .									

[1] All applications were made in a 7-inch banded spray in 22 gal/A @ 50 psi boom pressure. Plants in one randomly-selected paired-row per plot were inoculated with *Rhizoctonia solani* AG2-2 on 13 June, 2001 immediately after the first fungicide application and tillage.

[2] Ratings were taken on inoculated (I) and non-inoculated (N) rows separately.

[3] Treatment means followed by different letters differ significantly (Fisher-s protected LSD, P=0.05).

Research Project	**Timing of Quadris and Flint Applications for Rhizoctonia Root and Crown Rot Management in Sugar Beet, 2001**
Research Team Tel: 307-766-2397 FAX: 307-766-5549 francg@uwyo.edu	G.D. Franc, W.L. Stump and S.C. Briere University of Wyoming, Dept. of Plant Sciences P.O. Box 3354 (16th & Gibbon Streets) Laramie, WY 82071-3354
Field Plot Location	Torrington Research & Extension Center @ Torrington, WY. 4104 ft MSL; sandy loam soil; overhead irrigation
Plot Design	RCBD with 4 replications; plots were 4 rows (30-in row centers) X 20 ft; 5 ft in-row buffer. Fungicide treatments were made to, and all data were collected from, the center two rows of each plot. Rhizoctonia-inoculated and non-inoculated (natural inoculum) rows were paired within each plot.
Plot Management	**Planting Date**: 20 April. **Variety**: Monohikari. **Fertilizer**: 150 lbs N + 50 lbs P_2O_5 **Herbicide**: Post emergence applications of Progress + Upbeet + Stinger (17 fl oz + 0.5 oz + 4 fl oz product/A) on 16 May, Progress + Upbeet + Select (20 fl oz + 0.5 oz + 8 fl oz product/A) on 24 May, and Progress (20 fl oz + 8 fl oz product/A) + Select on 4 June. **Insecticide:** Asana (8 fl oz product/A) was applied for cabbage looper management on 11 June.
Disease Development	On 13 June, immediately following the first fungicide applications and cultivation, Rhizoctonia inoculum was applied to each plant in one randomly-selected center row of each plot. Inoculum (0.25 tsp = 0.8 g) was applied to the crown of each plant. Beets were in the 8 to 12-leaf growth stage at the time of inoculation. After inoculation, plots were irrigated three times during a 72 hour time period to favor infection. Inoculum was prepared from cultures of *Rhizoctonia solani* AG2-2 isolates grown on winter wheat, followed by air-drying and grinding. Rhizoctonia development in the non-inoculated row relied upon naturally occurring inoculum.
Treatment Applications	Fungicide (7-inch band) applications were made on 30 May, 6, 13, 20, 28 June, and 4 July. Fungicide was applied with the aid of a backpack sprayer in a total spray volume of 22 gal/A at 50 psi boom pressure. The boom was equipped with a single #8002 flat fan nozzle. The sugar beet canopy was closed within the row but not between rows on 20 June.
Disease Ratings	Rhizoctonia crown rot **incidence** was rated separately for the inoculated and non-inoculated rows (20 ft) on 10 and 25 July, and on 8 and 22

August. Infected beets were those that had rapidly wilting leaves, darkened petioles and/or decayed crowns evident with necrotic leaves present. At harvest on 25 September, both Rhizoctonia **severity** and **incidence** were rated from the 5 ft subsample dug to determine yields (see below). Disease severity was determined by visually estimating the volume of beet root affected by decay while disease incidence was a measure of the number of roots with any visible amount of decay.

Harvest

The inoculated and non-inoculated rows (5 ft) were dug separately on 25 September and total root yields were determined. The percentage of total sucrose and nitrate levels were determined by Holly Sugar=s laboratory.

Statistical Analysis

ANOVA with four replications. Mean separations were done using Fisher's protected LSD (P#0.05). Disease severity data for harvested beets (inoculated row) was transformed (Log_{10}) to correct for non-homogeneity prior to analysis. Data prior to transformation are presented in Table 2. Several plots did not have sufficient amounts of beet root to process by Holly Sugar=s laboratory. Rather than assign zero values for % sucrose and NO_3 ppm and artificially lowering treatment averages a plot average was used.

Results and Discussion

Following inoculation, Rhizoctonia root and crown rot development was evident in the plots by early July as rapidly wilting leaves with darkened petioles. However, disease incidence was relatively infrequent in the non-inoculated rows. Therefore, discussion of results will focus on data from the inoculated rows only.

Treatment effects on Rhizoctonia root and crown rot incidence are shown in Table 1. By 10 July, most Quadris and Flint treatments significantly suppressed disease development compared to the nontreated control (P#0.05). In general, the least effective treatments for Rhizoctonia suppression were those made two weeks before inoculation (too early) as well as those made three weeks after inoculation (too late). As the season progressed, Rhizoctonia disease incidence increased for most treatments as disease continued to develop. Treatments made prior to inoculation were generally less effective for season-long Rhizoctonia suppression compared to treatments made after inoculation (linear contrasts, P#0.05). Treatments made at the time of inoculation or as a split-application were more effective than treatments made after inoculation for most data collection dates (linear contrasts, P#0.05). Quadris treatments overall were more effective than Flint treatments for disease suppression for data collected from 25 July to 22 Aug (linear contrasts, P#0.05).

Treatment effects on disease incidence and disease severity measured on harvested beets are shown in Table 2. Most treatments had no significant effect on disease incidence at harvest (P#0.05). The most effective treatments for season-long disease suppression were the split

applications of fungicide. However, results are misleading because the less effective treatments lost beet roots entirely to rot prior to harvest. Therefore, few roots remained that could be rated for the data set (see Anumber of beets per 5 row ft@ in Table 3 for the number of beet roots that remained) and disease incidence was underestimated. Treatment applications made at inoculation or as a split application resulted in a decrease in the percentage of harvested beet roots with root and crown rot compared to applications made later (Table 2; linear contrasts, P#0.05). Quadris applied as a split application significantly reduced disease severity (surface area of root decayed) on harvested beets compared to the nontreated control (P#0.05).

All Quadris applications made at, and later than, 1 week prior to inoculation resulted in greater beet root numbers at harvest than the nontreated control (Table 3; P#0.05). In contrast, the Flint split application was the only Flint treatment that resulted in greater beet numbers at harvest than the nontreated control (P#0.05). Beet root yields were significantly greater for Quadris treatments compared to Flint treatments (linear contrasts, P#0.05). All Quadris treatments made at the time of inoculation or later had significantly greater yields than did the nontreated control (P#0.05). Flint applications made at inoculation and as a split application had significantly greater yields compared to the nontreated control (P#0.05). Treatments had no effect on nitrate levels (P=0.05) and the percentage of recoverable sucrose data showed no clear relationship to fungicide timing.

Results revealed that under optimal conditions for Rhizoctonia infection and disease development, properly-timed applications of Quadris or Flint significantly reduced disease. At comparable use rates Quadris was more effective than Flint for suppressing the incidence of decay and for increasing beet root yield (linear contrasts, P#0.05). Application timings that coincided with the time of inoculation or applications split between the time of inoculation and 2 weeks later generally were the most effective for the management of Rhizoctonia root and crown rot. The best estimate of the time of inoculation in growers= fields coincides with the time when tillage operations introduce contaminated soil onto the crown of the plant.

Table 1. Effects of Quadris and Flint treatment timings on Rhizoctonia root and crown rot disease development in sugar beet (G.D. Franc et al., U of WY; 2001).

Treatment	Timing and application rate (oz ai per 1000 ft) [1]	Number of beet crowns with visible rot per 20 row ft [2]							
		10 Jul		25 Jul		8 Aug		22 Aug	
		I	N	I	N	I	N	I	N
1. Nontreated Control....		12.8 a [3]	0.3 a	31.0 a	0.3 a	31.5 ab	1.8 a	28.8 ab	2.8 a
2. Quadris.....	2 weeks before inoculation (0.15)	4.4 b	0.3 a	24.7 ab	0.3 a	26.8 abc	0.8 a	26.8 abc	2.8 a
3. Quadris.....	1 week before inoculation (0.15)	0.5 b	0.0 a	11.0 def	0.0 a	22.5 bcd	0.8 a	24.8 a-d	0.3 a
4. Quadris.....	at inoculation (0.15)	0.5 b	0.0 a	1.3 f	0.3 a	6.0 g	0.3 a	6.5 fg	1.0 a
5. Quadris.....	1 week after inoculation (0.15)	1.8 b	0.0 a	11.0 def	0.0 a	12.8 e-g	0.5 a	15.3 d-g	1.8 a
6. Quadris.....	2 weeks after inoculation (0.15)	4.5 b	0.0 a	13.5 cde	0.3 a	16.8 def	0.8 a	17.8 b-e	1.0 a
7. Quadris.	3 weeks after inoculation (0.15)	6.3 ab	0.0 a	18.0 bcd	0.0 a	20.0 cde	0.0 a	17.8 b-e	0.0 a
8. Quadris.	at inoculation (0.075)	0.0 b	0.0 a	2.0 f	0.0 a	7.0 fg	0.5 a	5.3 g	0.3 a
8. Quadris.	2 weeks after inoculation (0.075)								
9. Flint.	2 weeks before inoculation (0.15)	13.0 a	0.0 a	27.0 ab	0.8 a	27.0 abc	1.8 a	26.0 a-d	1.5 a
10. Flint.	1 week before inoculation (0.15)	3.3 b	0.0 a	23.5 abc	0.0 a	33.5 a	1.0 a	32.3 a	0.5 a
11. Flint.	at inoculation (0.15)	0.0 b	0.0 a	5.5 ef	0.0 a	12.5 efg	0.5 a	12.8 efg	0.5 a
12. Flint.	1 week after inoculation (0.15)	2.3 b	0.0 a	11.8 def	0.0 a	21.0 cde	0.0 a	24.0 a-d	0.3 a
13. Flint.	2 weeks after inoculation (0.15)	4.0 b	0.0 a	18.0 bcd	0.0 a	19.8 cde	0.0 a	18.8 b-e	0.3 a
14. Flint.	3 weeks after inoculation (0.15)	6.3 ab	0.0 a	16.8 bcd	0.0 a	19.0 cde	1.5 a	19.5 b-e	1.0 a
15. Flint.	at inoculation (0.075)	0.0 b	0.0 a	7.7 def	0.0 a	14.0 d-g	2.0 a	17.0 c-f	1.9 a
15. Flint.	2 weeks after inoculation (0.075)								

[1] All applications were made in a 7-inch banded spray of 22 gal/A at 50 psi. Plants (one paired-row per plot) were inoculated with Rhizoctonia on 13 June and disease ratings were taken on the dates indicated in the Table.

[2] Ratings were taken on inoculated (I) and non-inoculated (N) rows, separately.

[3] Treatment means followed by different letters differ significantly (Fisher=s protected LSD, P=0.05).

Table 2. Effects of Quadris and Flint treatment timings on Rhizoctonia root and crown rot disease development on harvested beet roots (G.D. Franc et al., U of WY; 2001).

Treatment	Timing and application rate (oz ai per 1000 ft) [1]	Rhizoctonia incidence and severity on 25 Sep [2]					
		Number of harvested beets with rot per 5 row ft		Percentage of harvested beets with rot per 5 row ft		Surface area of root affected by rot (%)	
		I	N	I	N	I	N
1. Nontreated Control.....		2.8 bcd [3]	0.8 a	81.7 ab	6.3 a	43.8 abc	3.8 a
2. Quadris.....	2 weeks before inoculation (0.15)	3.6 abc	0.0 a	86.2 ab	0.0 a	68.3 a	0.0 a
3. Quadris.....	1 week before inoculation (0.15)	6.3 a	0.0 a	75.0 abc	0.0 a	63.8 a	0.0 a
4. Quadris.....	at inoculation (0.15)	1.5 cd	0.5 a	32.5 cd	6.3 a	9.5 bcd	8.8 a
5. Quadris.....	1 week after inoculation (0.15)	5.3 ab	0.8 a	56.3 abc	9.4 a	41.3abc	2.5 a
6. Quadris.....	2 weeks after inoculation (0.15)	5.8 a	0.3 a	59.1 abc	2.3 a	51.8 ab	0.5 a
7. Quadris.	3 weeks after inoculation (0.15)	4.0 abc	0.0 a	56.1 abc	0.0 a	48.8 abc	0.0 a
8. Quadris.	at inoculation (0.075)	0.5 d	0.8 a	5.3 d	8.8 a	1.8 d	5.8 a
8. Quadris.	2 weeks after inoculation (0.075)						
9. Flint.	2 weeks before inoculation (0.15)	1.3 cd	0.0 a	93.8 a	0.0 a	27.5 cd	0.0 a
10. Flint.	1 week before inoculation (0.15)	2.5 bcd	1.5 a	64.5 abc	15.0 a	55.5 abc	16.3 a
11. Flint.	at inoculation (0.15)	2.5 bcd	0.0 a	48.1 bcd	0.0 a	34.5 abc	0.0 a
12. Flint.	1 week after inoculation (0.15)	2.8 bcd	0.3 a	63.3 abc	2.1 a	58.8 ab	0.5 a
13. Flint.	2 weeks after inoculation (0.15)	2.3 cd	0.0 a	64.8 abc	0.0 a	56.8 abc	0.0 a
14. Flint.	3 weeks after inoculation (0.15)	3.5 abc	0.8 a	85.0 ab	6.3 a	76.3 a	3.8 a
15. Flint.	at inoculation (0.075)	3.7 abc	0.3 a	34.8 cd	1.8 a	25.8 abc	0.8 a
15. Flint.	2 weeks after inoculation (0.075)						

[1] All applications were made in a 7-inch banded spray of 22 gal/A at 50 psi. Plants (one paired-row per plot) were inoculated with Rhizoctonia on 13 June and disease ratings were taken on the dates indicated in the Table.

[2] Ratings were taken on inoculated (I) and non-inoculated (N) rows, separately.

[3] Treatment means followed by different letters differ significantly (Fisher-s protected LSD, P=0.05).

Table 3. Effects of Quadris and Flint treatment timings on sugar beet root yield and quality (G.D. Franc et al., U of WY; 2001).

Treatment	Timing and application rate (oz ai per 1000 ft) [1]	Beet yield and quality [2]							
		Number of beets per 5 row ft		Beet yield (tons/A)		Nitrate (ppm)		% total sucrose	
		I	N	I	N	I	N	I	N
1. Nontreated Control.....		3.8 ef [3]	10.0 a	4.7 de	19.6 a	231 cde	283 a	12.3 ab	15.0 a
2. Quadris	2 weeks before inoculation (0.15)	4.6 def	10.8 a	3.4 e	24.6 a	208 e	304 a	8.4 d	15.1 a
3. Quadris	1 week before inoculation (0.15)	8.5 a-d	8.3 a	14.9 a-d	18.5 a	304 abc	291 a	10.1 bcd	15.3 a
4. Quadris	at inoculation (0.15)	9.0 abc	10.5 a	22.0 a	24.4 a	337 a	244 a	12.7 ab	14.5 a
5. Quadris	1 week after inoculation (0.15)	9.5 ab	11.3 a	24.3 a	30.5 a	247 b-e	229 a	11.9 abc	15.5 a
6. Quadris	2 weeks after inoculation (0.15)	10.3 a	9.3 a	20.2 a	21.0 a	336 a	280 a	10.2 bcd	15.1 a
7. Quadris.	3 weeks after inoculation (0.15)	9.0 abc	8.8 a	17.7 abc	22.8 a	299 a-d	250 a	11.8 abc	15.3 a
8. Quadris.	at inoculation (0.075)	8.5 a-d	9.3 a	23.4 a	19.5 a	294 a-d	254 a	14.2 a	13.9 a
8. Quadris.	2 weeks after inoculation (0.075)								
9. Flint.	2 weeks before inoculation (0.15)	1.5 f	9.5 a	0.0 e	26.1 a	0.0 f	259 a	0.0 e	15.1 a
10. Flint.	1 week before inoculation (0.15)	5.3 b-f	9.8 a	8.0 b-e	26.1 a	357 a	278 a	11.6 abc	14.1 a
11. Flint.	at inoculation (0.15)	7.0 a-e	12.0 a	18.5 ab	26.9 a	327 ab	299 a	12.2 ab	14.7 a
12. Flint.	1 week after inoculation (0.15)	4.8 c-f	9.5 a	8.8 b-e	27.6 a	256 b-e	354 a	12.3 ab	14.8 a
13. Flint.	2 weeks after inoculation (0.15)	5.0 c-f	10.0 a	7.1 cde	23.8 a	251 b-e	346 a	12.3 ab	14.8 a
14. Flint.	3 weeks after inoculation (0.15)	4.3 def	10.8 a	4.0 e	22.0 a	221 de	264 a	9.2 cd	15.2 a
15. Flint.	at inoculation (0.075)	10.7 a	9.5 a	21.9 a	17.6 a	340 a	271 a	12.0 abc	15.0 a
15. Flint.	2 weeks after inoculation (0.075)								

[1] All applications were made in a 7-inch banded spray of 22 gal/A at 50 psi. Plants (one paired-row per plot) were inoculated with Rhizoctonia on 13 June and disease ratings were taken on the dates indicated in the Table.

[2] Ratings were taken on inoculated (I) and non-inoculated (N) rows, separately.

[3] Treatment means followed by different letters differ significantly (Fisher-s protected LSD, P=0.05).

Research Project	**Cercospora Management in Sugar Beet with Foliar Fungicide Programs, 2001**
Research Team Tel: 307-766-2397 FAX: 766-5549 francg@uwyo.edu	G.D. Franc and W.L. Stump University of Wyoming, Dept. of Plant Sciences P.O. Box 3354 (16th & Gibbon Streets) Laramie, WY 82071-3354
Field Plot Location	Torrington Research & Extension Center @ Torrington, WY. 4104 ft MSL; sandy loam soil; overhead irrigation
Plot Design	RCBD with 4 replications; plots were 4 rows (30-in row centers) X 20 ft; 5 ft in-row buffer. All treatments were made to, and all data were collected from, the center two rows.
Plot Management	**Planting Date**: 20 April. **Variety**: Monohikari. **Fertilizer**: 150 lbs N + 50 lbs P_2O_5 **Herbicide**: Post emergence applications of Progress + Upbeet + Stinger (17 fl oz + 0.5 oz + 4 fl oz product/A) on 16 May, Progress + Upbeet + Select (20 fl oz + 0.5 oz + 8 fl oz product/A) on 24 May, and Progress + Select (20 fl oz + 8 fl oz product/A) on 4 June. **Insecticide:** Asana (8 fl oz product/A) for cabbage looper on 11 June.
Disease Development	Scattered Cercospora lesions were first noted on 25 July and were the result of natural inoculum. On 7 August, one greenhouse-grown plant co-infected with *Cercospora beticola* and powdery mildew was transplanted into the buffer row of each treatment plot. Powdery mildew failed to develop during the remainder of the season and no data were collected.
Treatment Applications	Foliar fungicide applications indicated as A, B, and C in the tables were made on 1, 15, and 29 August respectively. Fungicides were applied with the aid of a portable (CO_2) sprayer in a total volume of 43 gal/A at 30 psi boom pressure (four #8004 flat fan nozzles spaced at 20 inches).
Disease Ratings	**Cercospora lesion counts** were determined on 31 July, 7, 14, 21, and 28 August, and 4, and 11 September. The lesions present on five leaves per plot were counted and the averages calculated. A portion of the field data is summarized in Table 1. All data are summarized in Appendix 1.
Harvest	One row X 20 ft was harvested on 25 September. The

	percentage of total sucrose and nitrate levels were determined by Holly Sugar=s testing laboratory.
Statistical Analysis	The design was an ANOVA with four replications. Mean separations were done using Fisher's protected LSD (P#0.05).

Results and Discussion

Cercospora leaf spot (CLS) development was moderate in 2001 and field symptoms were initiated by naturally occurring inoculum. After disease initiation, greenhouse-grown inoculated plants transplanted into the plots also contributed to disease development. The transplants were inoculated with fungus isolates sensitive to benzimidazole and triphenyltin hydroxide fungicides. CLS initially developed rapidly in the field due to warm night temperatures and humid days and a severe epidemic seemed likely. However, cooler temperatures followed during the latter half of August and continued into September, thus, considerably slowing CLS development. Powdery mildew signs also were evident on transplants at the time they were placed in the field. However, powdery mildew failed to develop substantially in the field plots, and no data on its management were collected.

CLS disease severity data collected from 7 to 21 August revealed no significant differences (P=0.05) among treatment means (data not shown except for 21 August). By 28 August, all fungicide programs significantly suppressed CLS lesion development compared to the nontreated check (P#0.05). Due to death of older and more heavily infected leaves, fewer lesions were counted on 11 September compared to 4 September. The AUDPC for data collected 1 August through 11 September is an estimate of season-long disease severity. The AUDPC was significantly less for all fungicide programs compared to the nontreated check (P#0.05).

Phytotoxicity in the form of necrotic leaf speckling, was observed for fungicide programs that were initiated with Headline plus Agridex (i.e., when this application was made on 1 August). Several photographs of these symptoms were taken.

Fungicide treatment programs had no effect on sugar beet root yield and sugar quality (Table 2, P=0.05). Yield variability was increased due to the presence of Rhizoctonia root and crown rot and weed pressure.

Table 1. The effects of foliar fungicide programs on Cercospora disease progression in sugar beet (G.D. Franc and W.L. Stump, U of WY; 2001).

Treatment and Application Rate (lb a.i./ acre)	Application dates [1]	No. of Cercospora lesions per leaf				AUDPC [2]
		21 Aug	28 Aug	4 Sep	11 Sep	
1. Nontreated Check	A-C	57.2 a [3]	146.5 a	201.0 a	133.9 a	3812 a
2. Flint (0.08)	A-C	50.6 a	63.1 b-e	56.8 cde	24.1 bc	1870 b-e
3. Flint (0.10)	A-C	73.7 a	45.8 b-e	49.1 cde	34.2 bc	1716 b-e
4. Flint (0.11)	A-C	45.4 a	50.6 b-e	18.5 e	9.5 c	1310 b-e
5. Stratego (0.16)	A-C	88.5 a	58.2 b-e	32.2 de	30.8 bc	2062 bcd
6. Eminent (0.11)	A-C	13.7 a	25.6 e	36.4 de	14.7 c	877 e
7. Headline + Agridex (0.15 + 1% v:v)	A-C	68.7 a	28.1 de	27.6 de	18.9 bc	1213 cde
8. Headline + Agridex (0.15 + 1% v:v) 8. Eminent (0.11)	A, C B	91.2 a	76.4 bc	42.7 cde	13.8 c	1788 b-e
9. Eminent (0.11) 9. Headline + Agridex (0.15 + 1% v:v)	A, C B	49.4 a	41.9 b-e	87.7 bcd	26.7 bc	1633 b-e
10. Eminent (0.11) 10. AgriTin (0.25)	A, C B	42.9 a	35.6 b-e	83.5 bcd	36.9 bc	1482 b-e
11. Eminent (0.11) 11. Headline (0.15) 11. AgriTin (0.25)	A B C	21.9 a	37.5 b-e	73.9 b-e	31.4 bc	1275 b-e
12. Eminent (0.11) 12. SuperTin (0.25)	A, C B	18.9 a	59.1 b-e	131.4 b	57.3 b	1945 b-e
13. SuperTin (0.18)	A-C	82.5 a	58.7 b-e	102.1 bc	47.1 bc	2362 bc
14. Headline + Agridex (0.15 + 1% v:v) 14. SuperTin (0.25)	A, C B	78.5 a	72.1 bcd	69.8 b-e	20.0 bc	1938 b-e
15. AgriTin (0.25) 15. Headline + Agridex (0.15 + 1% v:v)	A, C B	53.5 a	31.1 cde	36.5 de	25.4 bc	1188 de
16. Headline + Agridex (0.15 + 1% v:v) 16. AgriTin (0.25)	A, C B	76.6 a	67.7 b-e	68.4 cde	16.3 bc	1876 b-e
17. AgriTin (0.25) 17. Eminent (0.11)	A, C B	88.4 a	78.3 b	73.5 b-e	35.0 bc	2417 b

[1] Application dates: A=1 August , B=15 August , and C=29 August.

[2] Area under the disease progress curve for lesion count data collected 1 August through 11 September.

[3] Treatment means followed by different letters differ significantly (Fisher-s protected LSD, P=0.05).

Table 2. The effects of foliar fungicides on sugar beet yield and quality G.D. Franc and W.L. Stump, U of WY; 2001).

Treatment and Application Rate (lb a.i./ acre)	Application dates [1]	Nitrate (PPM)	Beet yield (T/A)	% total sucrose	Sucrose yield (T/A)
1. Nontreated Check	A-C	335 a	18.4 a	13.9 a	2.6 a
2. Flint (0.08)	A-C	291 a	18.1 a	14.8 a	2.7 a
3. Flint (0.10)	A-C	375 a	18.9 a	13.6 a	2.6 a
4. Flint (0.11)	A-C	316 a	15.5 a	14.3 a	2.2 a
5. Stratego (0.16)	A-C	344 a	17.8 a	14.4 a	2.6 a
6. Eminent (0.11)	A-C	272 a	16.0 a	14.4 a	2.3 a
7. Headline + Agridex (0.15 + 1% v:v)	A-C	323 a	20.4 a	13.7 a	2.9 a
8. Headline + Agridex (0.15 + 1% v:v)	A, C	317 a	25.3 a	14.9 a	3.8 a
8. Eminent (0.11)	B				
9. Eminent (0.11)	A, C	349 a	11.4 a	13.0 a	1.5 a
9. Headline + Agridex (0.15 + 1% v:v)	B				
10. Eminent (0.11)	A, C	403 a	15.8 a	13.5 a	2.1 a
10. AgriTin (0.25)	B				
11. Eminent (0.11)	A	347 a	13.2 a	13.0 a	1.8 a
11. Headline (0.15)	B				
11. AgriTin (0.25)	C				
12. Eminent (0.11)	A, C	364 a	27.2 a	13.9 a	3.8 a
12. Super Tin (0.25)	B				
13. Super Tin (0.18)	A-C	284 a	22.3 a	14.5 a	3.2 a
14. Headline + Agridex (0.15 + 1% v:v)	A, C	304 a	26.1 a	14.4 a	3.8 a
14. Super Tin (0.25)	B				
15. Agri Tin (0.25)	A, C	305 a	16.0 a	14.4 a	2.3 a
15. Headline + Agridex (0.15 + 1% v:v)	B				
16. Headline + Agridex (0.15 + 1% v:v)	A, C	339 a	21.6 a	14.0 a	3.1 a
16. Agri Tin (0.25)	B				
17. Agri Tin (0.25)	A, C	362 a	22.2 a	13.7 a	3.0 a
17. Eminent (0.11)	B				

[1] Application dates: A=1 August , B=15 August , and C=29 August.

[2] Treatment means followed by different letters differ significantly (Fisher-s protected LSD, P=0.05).

Research Project	**Insect Management in Potato with Seedpiece and Foliar Insecticide Applications, 2001**
Research Team Tel: 307-766-2397 FAX: 766-5549 francg@uwyo.edu	G.D. Franc and W.L. Stump University of Wyoming, Dept. of Plant Sciences P.O. Box 3354 (16th & Gibbon Streets) Laramie, WY 82071-3354
Field Plot Location	Torrington Research & Extension Center @ Torrington, WY. 4104 ft MSL; sandy loam soil; overhead irrigation
Plot Design	RCBD with 4 replications; treatment plots were 4 rows (36-in row centers) by 20 ft; with a 5 ft in-row buffer. All treatments were made to, and all data were collected from, the center two rows of each treatment plot.
Plot Management	**Planting Date**: 17 May. **Variety**: Atlantic. **Fertilizer**: 150 lb N + 50 lb P_2O_5 on 31 March, 2001 **Herbicide**: Eptam + Prowl (3 pt + 1.2 pt/acre) PRE on 17 May. **Insecticide**: Asana (4 fl oz/acre)was applied on 18 June for Colorado potato beetle management and to artificially flare natural aphid populations. Asana was applied to the entire field plot area, including buffer rows.
Insect Development	Insect development relied on natural infestations. The buffer rows separating treatment plots were left untreated in an effort to provide greater pest pressure. Psyllid pressure was light with populations peaking during early-August. Symptoms of Psyllid Yellows were mild but evident in the plot area during peak populations. Aphids were present during the season, but in low numbers.
Treatment Applications	**Seedpiece** treatments were made on 14 May to freshly cut seed. **Foliar broadcast** applications were made on 1 August in a total volume of 43 gal/A @ 30 psi boom pressure (four #8004 flat fan nozzles spaced @ 20 inches). Foliar applications were not made until pests were present and evident.
Insect Ratings	The average number of psyllid nymphs and aphids (species not identified) were determined for 5 leaves/plot on 31 July and 7 August. Additionally, using a beater-board, the average number of insect pests were determined from two sites per plot on 14 August. Insects recorded were aphid, leaf hopper,

	and Colorado potato beetle (both adult and larval forms).
Statistical Analysis	ANOVA with four replications. Mean separations were done using Fisher's protected LSD (P=0.05).

Results and Discussion

No phytotoxicity from insecticide treatments was observed during the growing season. Aphid numbers were too low throughout the season to measure treatment effects (Table 1, P=0.05). Treatment effects were measured for the psyllid population. However, psyllid numbers also were very low, making it difficult to measure meaningful treatment effects. Psyllid numbers measured on 31 July, prior to application of foliar treatments, were unaffected by the seedpiece treatment (P=0.05). Psyllid numbers also were unaffected one week after foliar treatments with insecticide (P=0.05).

Data in Table 2 summarizes treatment effects for Colorado potato beetle and leafhopper populations. Once again, these populations were low and it is difficult to make firm conclusions regarding treatment effects. Most insecticide treatments, with the exception of Fulfill (primarily an aphicide) Calypso (0.9), and Maxim/Adage treatments significantly reduced by mid-August the number of Colorado potato beetles present in the canopy relative to the nontreated control (P#0.05). Results for leafhopper control were more mixed among treatments (P#0.05). Leafhoppers were not detected in the Monitor and Leverage treatment plots.

Table 1. The effects of seedpiece and foliar insecticide applications on foliar aphid and psyllid populations (Franc and Stump, U of WY; 2001).

Treatment and rate (lbs ai/A) [1]	No. of Aphids per leaf		No. of Aphids per beater-board [2]	No. of Psyllid nymphs per leaf	
	31 July	7 Aug	14 Aug	31 July	7 Aug
1. Nontreated Check	0.0 a [3]	0.0 a	0.0 a	0.4 b	0.1 a
2. Provado 1.6 SC (0.05)	0.0 a	0.1 a	0.3 a	0.1 b	0.1 a
3. Provado 75 WG (0.05)	0.0 a	0.0 a	0.0 a	0.2 b	0.0 a
4. Confidor (0.05)	0.0 a	0.0 a	0.1 a	0.1 b	0.1 a
5. Calypso 4 SC (0.05)	0.0 a	0.0 a	0.4 a	0.5 b	0.1 a
6. Calypso 4 SC (0.09)	0.0 a	0.0 a	0.1 a	1.2 a	0.0 a
7. YRC2894 (0.05)	0.0 a	0.0 a	0.1 a	0.1 b	0.2 a
8. Leverage (0.08)	0.2 a	0.0 a	0.3 a	0.2 b	0.1 a
9. KK03334 (0.02)	0.1 a	0.1 a	0.1 a	0.1 b	0.1 a
10. Fulfill (0.09)	0.0 a	0.0 a	0.1 a	0.1 b	0.2 a
11. Monitor (1.0)	0.0 a	0.0 a	0.0 a	0.1 b	0.1 a
12. Maxim/Adage (8 oz product per 100 cwt cut seed).	0.0 a	0.0 a	0.1 a	0.1 b	0.0 a

[1] Seedpiece treatments were made on 14 May to freshly cut seed. Foliar broadcast applications were made on 1 August.

[2] Beater-board surface area was approximately 90 square inches.

[3] Treatment means followed by different letters differ significantly (Fisher-s protected LSD, P=0.05).

Table 2. The effects of seed piece and foliar treatments on Colorado potato beetle and leafhopper populations (Franc and Stump, U of WY; 2001).

Treatment and rate (lbs ai/A) [1]	14 Aug insect counts per beater-board [2]	
	Colorado Potato Beetle [3]	Leafhopper
1. Nontreated Check	0.38 ab [4]	1.38 ab
2. Provado 1.6 SC (0.05)	0.00 c	0.5 bc
3. Provado 75 WG (0.05)	0.00 c	0.38 bc
4. Confidor (0.05)	0.00 c	0.25 c
5. Calypso 4 SC (0.05)	0.00 c	0.88 abc
6. Calypso 4 SC (0.09)	0.13 bc	0.25 c
7. YRC2894 (0.05)	0.00 c	0.50 bc
8. Leverage (0.08)	0.00 c	0.00 c
9. KK03334 (0.02)	0.00 c	0.63 bc
10. Fulfill (0.09)	0.63 a	1.88 a
11. Monitor (1.0)	0.00 c	0.00c
12. Maxim/Adage (8 oz product per 100 cwt cut seed).	0.13 bc	0.50 bc

[1] Seedpiece treatments were made on 14 May to freshly cut seed. Foliar broadcast applications were made on 1 August.

[2] Beater-board surface area was approximately 90 square inches.

[3] Colorado potato beetle count includes both adults and larvae.

[4] Treatment means followed by different letters differ significantly (Fisher-s protected LSD, P=0.05).

Wyoming Cotton Variety Trials, 2001

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Introduction

A study was initiated to better understand the challenges of growing cotton in Wyoming. The development of cold tolerant varieties, colored lint varieties, and the absence of cotton pests in the High Plains, may provide a niche market for our producers. We had no information on the practical aspects of growing cotton in the High Plains and wanted to generate some preliminary data.

Ten Avarieties,@ some of which were experimental lines, were planted at the University of Wyoming Research and Extension Center in Torrington, WY. Varieties were chosen to compensate for anticipated environmental challenges to cotton production in the High Plains. Several industry standards also were included for comparison to experimental lines. Anticipated environmental challenges required the selection of varieties with a short growing season and cold tolerance characteristics, as well as those that could be grown with fewer degree-days (narrow-row varieties).

Materials and Methods

A list of varieties and their characteristics are summarized in Table 1. Those listed with a AWYO@ prefix are experimental lines. Cotton seed was provided by California Planting Cotton Seed Distributors of Shafter, CA. Seed had been treated with NuFlow ND7 immediately after de-linting and soil was treated with Treflan7 prior to planting. Seed was planted on May 17, 2001. Each of the four replicates contained 10 plots with two 32 ft. rows in each plot. A Hegge precision planter was used to place four seeds per 1 row foot at a 1.5-inch depth. The soil temperature at the time of planting was 22.5EC Plots were sprinkler irrigated weekly.

Stand counts were taken on 7/17/01 and 9/4/2001. Roundup7 was applied to plants on 9/28/01 to promote defoliation prior to boll harvest. Mature (open) bolls and immature (non-open) bolls were counted on five randomly selected plants per plot on 11/14/2001.

Data were analyzed using Analysis of Variance (ANOVA). When significant variation among varieties was found, Duncan=s multiple range (DMR) was used to separate and rank the means.

Results

The overall stand counts were significantly different ($\underline{P} < 0.0001$). The DMR ranking of stand is summarized in Table 2. The overall boll counts were significantly different ($\underline{P} < 0.0001$) and the DMR ranking is summarized in Table 3. All data collected from the plots are summarized in Appendix 1.

Discussion

Due to the possibility of frost, planting was delayed until mid-May. If we were able to plant earlier, an additional two weeks of growth at the end of the growing season would probably have increased maturity and opened more bolls.

Stand counts were performed on two dates because of damage that occurred to plots shortly after seedlings emerged. While seedlings could be seen 10 days after planting, a windstorm occurred two weeks after planting that caused sand to blow onto the newly emerged seedlings for two days. This resulted in seedling death and damage, and slowed development of the plants. Visual inspection suggested the damage from the windstorm delayed plant growth by approximately two weeks. A second stand count was performed about six weeks after the first stand count.

Boll counts included only immature bolls due to the fact that by the end of the season, none of the bolls had matured sufficiently to open. While a few had cracked, it was unknown whether this was due to maturity or weather. By the time boll counts were done, several freeze/thaw cycles had occurred. However, due to the size of most non-open bolls, it was estimated that only one week or so of warm weather would have been sufficient to open most bolls.

A measurement of vigor was attempted in mid-August. Unfortunately, a hailstorm occurred the day before causing any rating of vigor to be worthless. All the plots experienced torn leaves and aborted bolls.

While Acala Maxxa had a low boll count, its high stand count makes it a good candidate for further testing and breeding programs. Acala Maxxa is one of the industry standards used in this test. It is a hardy variety, which may have aided it in overcoming the impact of the harsh windstorm early in the season. WYO #35 is a short season experimental line cotton with good cold tolerance. It is important to note that the cultivars with the higher boll counts (WYO #28 and #20) did not have high stand counts. These should not be overlooked in possible future breeding studies, however, due to their high boll counts. Breeding the high boll count into a cold tolerant seed line could be the key to further cotton cultivation in Wyoming.

Despite the fact that there was no harvestable lint, the experiment was successful in respect to determining the challenges to growing cotton in Wyoming. While the cold temperatures were certainly a factor in plant development, the high winds and hail had a much greater impact.

Future research in Wyoming should be directed at finding storm and cold tolerant seed lines. Our biggest problem came from a windstorm early in the season and a hailstorm later in the season. There are many so-called Astorm-proof@ cotton lines developed for use in the Texas High Plains. Another suggestion for future research is the use of mepiquat chloride, which has been shown to increase cold tolerance in cotton seedlings. This may enable earlier planting needed for boll maturity. Also, planting directly into wheat stubble or between corn borders offer protection and reduce wind damage to young seedlings. Staggered planting dates and

varying plot locations could help reduce the impact of harsh weather and may aid in conducting future research.

Table 1. The cotton varieties and experimental lines tested in the field at Torrington, WY, and their general growth characteristics.

Variety	General Growth Characteristics
Delta Pine NuCotton 33b	Industry Standard, Some Cold Tolerance
Acala Riata	Industry Standard, Roundup Ready
Acala Maxxa	Industry Standard, High Yield
WYO #15	Experimental, Short Season, Narrow-Row
WYO #20	Experimental, Short Season, Narrow-Row
WYO #28	Experimental, Short Season, Narrow-Row
WYO #32	Experimental, Short Season, Narrow-Row
WYO #35	Short Season, Cold Tolerant
WYO #36	Experimental, Short Season, Cold Tolerant
WYO #40	Brown Lint, Short Season, Narrow-Row

Table 2. ANOVA table for stand counts of each variety.

Variety	Mean	Duncan Grouping
Acala Maxxa	14.68	A
WYO #35	13.38	A, B
Acala Riata	10.13	B, C
WYO #20	9.00	C, D
WYO #28	8.94	C, D
WYO #32	8.81	C, D
WYO #40	8.50	C, D
DP NuCotton 33B	7.94	C, D
WYO #36	6.00	D, E
WYO #15	4.06	E

Table 3. ANOVA table for boll counts of five randomly selected plants of each variety at season-s end.

Variety	Mean	Duncan Grouping
WYO #28	11.80	A
WYO #20	9.25	B
WYO #15	8.30	B, C
WYO #35	8.00	B, C, D
Acala Riata	7.95	B, C, D
WYO #40	7.50	B, C, D
Acala Maxxa	7.30	B. C, D
WYO #32	6.75	C, D, E
WYO #36	5.95	D, E
DP NuCotton 33B	5.00	E

Appendix 1. Replicated data set.

Plot	Treatment	Stand Counts				Bolls per Plant				
		7/17/2001		9/4/2001		#1	#2	#3	#4	#5
101	DP Nucotton	8	1	9	4	6	6	7	5	5
102	Riata	11	6	11	6	7	6	6	7	5
103	WYO #15	1	5	2	5	4	4	8	5	8
104	WYO #20	11	11	11	11	8	8	11	12	9
105	WYO #28	9	1	9	1	15	10	12	9	10
106	WYO #32	10	17	10	17	9	11	9	10	9
107	WYO #35	15	25	15	25	3	3	4	3	0
108	WYO #36	4	13	4	14	3	2	2	4	3
109	WYO #40	16	10	16	10	5	4	3	4	3
110	Maxxa	24	24	24	24	5	12	8	6	6
201	WYO #20	12	12	12	14	17	15	14	9	8
202	Maxxa	10	8	12	9	5	4	6	7	6
203	DP Nucotton	10	10	12	11	6	5	6	5	0
204	WYO #28	6	6	7	6	10	12	10	10	11
205	WYO #40	7	5	7	6	14	9	7	8	7
206	WYO #35	2	6	4	9	9	6	9	10	8
207	WYO #15	6	5	6	6	7	12	12	8	10
208	WYO #36	1	4	1	5	7	9	8	8	7
209	WYO #32	15	17	16	17	8	7	4	8	7
210	Riata	14	15	18	18	9	12	10	10	12
301	WYO #15	2	4	3	4	8	7	8	8	9
302	Riata	6	2	6	4	6	6	9	8	6
303	WYO #40	3	9	4	9	10	8	10	9	8
304	WYO #20	2	8	4	9	5	7	5	5	8
305	WYO #32	1	0	1	0	-	-	-	-	-
306	DP Nucotton	1	5	4	5	-	-	-	-	-
307	WYO #36	13	1	13	5	7	6	6	5	6
308	WYO #28	8	10	10	10	10	12	12	13	11
309	Maxxa	13	14	14	15	8	9	8	7	9
310	WYO #35	17	15	19	16	7	10	9	8	8
401	WYO #20	8	3	9	7	7	10	7	10	10
402	WYO #15	3	4	5	4	13	7	10	8	10
403	WYO #36	4	4	4	6	8	7	6	7	8
404	WYO #32	0	9	2	9	12	10	10	9	12
405	Maxxa	9	13	9	13	7	8	8	8	9
406	Riata	12	9	15	9	9	8	9	7	7
407	WYO #40	8	7	11	8	8	9	7	8	9
408	WYO #35	11	9	15	11	13	12	13	14	11
409	WYO #28	17	11	19	13	14	15	12	13	15
410	DP Nucotton	12	6	18	11	10	9	10	11	9

Bacterial Ring Rot Symptom Development in Selected Potato Cultivars by Stem and Petiole Inoculation, 2001

By: Ryan Wess

Abstract

A bacterial ring rot (Greenhouse) trial was performed at the University of Wyoming Greenhouse Complex in Laramie, Wyoming. Potato cultivars ›Atlantic= and ›Norkotah= were inoculated at either their stem or petiole with *Clavibacter michiganensis* ssp. *sepedonicus* (CMS) bacteria and compared to untreated controls for CMS development in foliage and tubers. Results indicate that the CMS bacterium moved from inoculated stems or petioles to developing tubers. Stem inoculations in both ›Atlantic= and ›Norkotah= cultivars showed the greatest percentage of tuber symptoms. Therefore, the study indicates that inoculation of above-ground stems and petioles may result in tuber infection.

Introduction

Bacterial ring rot is an important disease of potatoes; there is a zero tolerance for this disease in seed certification programs. If one plant or tuber in a seed lot is diagnosed with ring rot, the entire seed lot is rejected for certification. When ring rot symptoms appear in the field, it can lead to high yield and storage decay losses. A Colorado State University News Release from 1998 reports Aa single plant with symptoms of ring rot infection in a field of potatoes can cost a farmer as much as $80,000 in lost revenue.@ In another report, Alberta Agriculture, Food and Rural development conclude Afive percent bacterial ring rot infection of tubers may result in complete loss of the harvested crop during storage.@

Ring rot is caused by the bacteria *Clavibacter michiganensis* subsp. *sepedonicus* (CMS). Infected potatoes show wilted leaves and stems after midseason. A milky exudate can be squeezed from the vascular ring of tubers. Infection can occur through tuber wounds, contaminated seed cutting knives, and abrasion of stems, roots, or stolons. The bacterium is a vascular parasite that inhibits the xylem. When a stem grows from an infected tuber, the bacterium moves up the xylem, multiplies, and eventually moves to developing tubers. The purpose of this study was to determine if the ring rot bacterium is able to move downward from inoculated petioles and/or stems to developing tubers. This research is relevant because insects can transmit the ring rot bacterium to healthy foliage during feeding. However, it is not known if bacteria transmitted by insects are actually translocated to tubers. Also, machinery moving through fields crush stems and may transmit inoculum to above-ground plant parts. If translocation does occur, contaminated insects and/or equipment will be an important source of inoculum for subsequent generations of the potato crop.

Materials and Methods

The bacterial ring rot trial was performed at the University of Wyoming Greenhouse Complex in Laramie, Wyoming. The study was conducted inside the greenhouse, in a controlled environment. Prior to planting, a sterilized soil mixture was prepared; Perlite and Osmocote were added to native soil for optimum drainage and nutrient supply. Potato cultivars ›Atlantic‹ and ›Norkotah‹ were planted on May 23 in 6-inch pots. Fifty pots of each variety were planted with eyes scooped melon-ball style from certified seed. The plants were watered daily. On June 1, plants began to emerge and an insecticide application of Temik was added per 6-inch pot.

Once cultivars ›Atlantic‹ and ›Norkotah‹ grew 10 inches in height, they were separated into four treatments, an untreated stem check, untreated petiole check, inoculated petiole, and inoculated stem. This occurred on June 25. Twelve plants represented each treatment in ›Atlantic‹ and ›Norkotah‹. To simulate insect damage in potato plants, a stem and petiole stem crush was performed using pliers. Un-contaminated pliers were used to crush untreated plant checks. Pliers dipped in water contaminated with CMS were used to crush and apply bacteria to treated plants. Bacteria was obtained by squeezing symptomatic tubers previously infected with CMS.

On June 25, twelve ›Atlantic‹ and ›Norkotah‹ positive checks were planted to identify if bacteria used during inoculation was CMS. Melon-ball scooped eyes from certified seed were dipped in bacteria and planted. Upon emergence (July 3), Temik was applied at 1/8 teaspoon per 6-inch pot.

Untreated cultivars of ›Atlantic‹ and ›Norkotah‹ were separated from inoculated stem and petiole treatments to avoid bacterial contamination. All inoculated plants were placed together, on separate benches from untreated checks.

On August 10, all ›Atlantic‹ and ›Norkotah‹ plants were visually rated for foliar symptoms and necrosis. Visual symptoms were rated using a foliar symptom code defined in Table 1. Plants were visually rated using the Horsfall-Barratt scale (0-11) to estimate the percentage of foliar necrosis on August 10. All potato plants were hand harvested on November 14 at the University of Wyoming Greenhouse Complex and separated by pot number and treatment into paper bags. Tubers were then placed in cold storage for CMS development.

All tubers were evaluated on December 5. Tubers were cut at the stem end and squeezed for signs of bacterial ooze. All data was analyzed with ›PC-SAS‹ as a factorial Anova with two cultivars and four treatment levels. Mean separation was accomplished with a Fisher‹s protected LSD, $\underline{P}=0.05$.

Results and Discussion

The study found that treatments affected potato cultivars differently. The untreated stem, untreated petiole, and inoculated petiole treatments had less significant necrosis than the inoculated stem treatment. This may be due to different CMS progression rates in cultivars. Therefore, data is presented for ›Atlantic‹ and ›Norkotah‹ separately.

The effects of ring rot inoculation via potato plant stems and petiole for ›Atlantic‹ and ›Norkotah‹ are shown in Table 1. When comparing ›Atlantic‹ treatments for average percent necrosis, the inoculated treated stem was more significant when compared to inoculated petiole, untreated stem, and untreated petiole. The range of visual symptoms observed on August 10, agree with this assessment because the treated stem treatments experienced significantly greater symptom development than the untreated checks. When comparing CMS tuber symptom development in cultivar ›Atlantic,‹ the treated stem inoculation showed the highest percentage of tuber infection. The petiole inoculation resulted in more significant infected tubers when compared to the untreated stem and petiole checks.

Average percent necrosis was lowest for the inoculated petiole in cultivar ›Norkotah‹. All other treatments were not significantly different from the checks. However, overall foliar symptoms for this cultivar were minimal at the time of observation and no interveinal necrosis or chlorosis was found, both of which are symptoms of infection with CMS. ›Norkotah‹ probably needed more time to show visual symptoms. When evaluating tuber symptoms, the inoculated stem had the highest percentage of symptom expression. The inoculated petiole was not significant from the untreated checks. The cultivar ›Norkotah‹ probably requires more time in cold storage to increase CMS development in tubers.

Positive checks showed little visual symptoms or tuber expression at the time of observations. This was likely due to the later planting on June 25, which means the CMS bacterium had little time to progress to tubers. Positive checks did not show foliar symptoms of wilt, interveinal necrosis, and chlorosis until September. Therefore, disease progression may not have occurred all the way down to tubers by the December 10 observation.

Insects can transmit the ring rot bacterium to healthy foliage during feeding. Additionally, machinery moving through fields can spread CMS through physical injury. However, it is not known if the bacterium transmitted by insects and/or machinary is actually translocated to tubers. Results of this study indicate that ring rot bacterium is moving from infected above-ground tissue to developing tubers. Stem inoculations in both ›Atlantic‹ and ›Norkotah‹ cultivars showed the highest percentage of tuber symptoms when compared to their respective cultivar

treatments. Although the inoculated petiole in ›Atlantic= was more significant from its checks, the study indicates that stem infections result in CMS progress to foliage and tubers more rapidly than petiole inoculations. Therefore, both contaminated insects and machinery can infect healthy above-ground potato tissue resulting in tuber infection.

Table 1. Foliar Ringrot symptoms and tuber symptom expression following stem and petiole inoculation with *Clavibacter michiganensis* ssp. *sepedonicus* (CMS).

Cultivar	Treatment [1]	Average percent foliar necrosis [2] 8/10/01	Range of visual symptoms observed [3]	Number of tubers evaluated 12/5/01	Percentage of tubers expressing symptoms 12/5/01
Atlantic	Untreated stem	1.16 b [4]	C	57	0.00 c
	Untreated petiole	1.41 b	C	44	0.00 c
	Inoculated petiole	1.58 b	W, N	49	0.22 b
	Inoculated Stem	6.00 a	W, N, IVN, IVC	32	0.53 a
Norkotah	Untreated stem	2.50 a	C	28	0.00 b
	Untreated petiole	2.58 a	C	28	0.00 b
	Inoculated petiole	1.50 b	W, N	28	0.12 b
	Inoculated Stem	2.33 a	W, N	30	0.36 a

[1] Treatments include injury to stems +/- CMS bacteria and injury to leaf petiole stems +/- CMS bacteria.

[2] Foliar data presented were converted from Horsfall-Barratt scale (0-11) data.

[3] Foliar symptom Code: C= chlorosis, W= wilt, N= necrosis, IVN= interveinal chlorosis, IVN= interveinal necrosis

[4] Cultivars analyzed separately. Treatment means followed by different letters within each cultivar, differ significantly (Fisher=s protected LSD, P_ 0.05).

Products Tested in 2001 Research Studies.

Product	Manufacturer	Composition
Agridex	Helena Chemical Co 6075 Poplar, Suite 500 Memphis, TN 38119	Spray oil concentrate
AgriTin 80WP	Agtrol Chemical Products 7322 SW Freeway, Suite 1400 Houston, TX 77074	80% Triphenyltin Hydroxide
BAS 500 2.08EC	BASF Corp. 26 Davis Dr Research Triangle Park, NC 27709	Kresoxim-methyl
BAS 510 70WP	BASF Corp.	Kresoxim-methyl
Bravo Weather Stik 6F	Syngenta Crop Protection, Inc. P.O. Box 18300 Greensboro, NC 27419	54% Chlorothalonil
Bravo ZN 4.17F	Syngenta Crop Protection, Inc.	40.4% Chlorothalonil
Calypso 4SC	Bayer Corp. Agriculture Division P.O. Box 4913, Hawthorn Rd Kansas City, MO 64120	Thiacloprid
Champ 57.6WP	Agtrol Chemical Products	57.6% Copper hydroxide
Cofidor 200SL	Bayer Corp.	Information not provided
Cursate 60DF	DuPont Agricultural Products Wilmington, DE 19880-0402	60% Cymoxanil
Dithane NT 75DF	Dow AgroSciences 9330 Zionsville Rd Indianapolis, IN 46268-1054	75% Mancozeb
Echo ZN 4.17F	Sipcam Agro USA, Inc. 70 Mansell Ct., Suite 230 Roswell, GA 30076	38.5% Chlorothalonil
Eminent 1.04SC	Sipcam Agro USA, Inc.	11.6% Tetraconazole
Equus 82.5DF	Griffin Corp. P.O. Box 1847, Rocky Ford Rd Valdosta, GA 31603-1847	82.5% Chlorothalonil
Equus ZN 4.17F	Griffin Corp.	40.4% Chlorothalonil
Flint 4.17SC	Bayer Corp.	Trifloxystrobin
Flouronil	Agtrol Chemical Products	4.4% Mefenoxam, 72%

		Chlorothalonil
Product	**Manufacturer**	**Composition**
Fulfill 50WG	Bayer Corp.	50% Pymetrozine
Gavel 75DF	Dow AgroSciences	8-9% Zoxamide, 21-25% Sodium Lignosulfonate, 67-70% Mancozeb
GX70001 A 3.6EC	Griffin Corp.	42% Propiconazole
Headline 2.09EC	BASF Corp.	Kresoxim-methyl
KK03334 25WG	Bayer Corp.	25% Thiamethoxam
KQ667 68.8WG	DuPont	Information not provided
Leverage 2.7SC	Bayer Corp.	12% Cyfluthrin, and 17% Imidacloprid
Manex II 4F	Griffin Corp.	37% Maneb (7.6% metallic)
Manzate 75DF	Griffin Corp.	75% Mancozeb
Maxim/Adage 1.7D	Syngenta Crop Protection, Inc.	Seed treatment containing Fludioxonil and Thiamethoxam
Monitor 4SC	Bayer Corp.	40% Methamidophis
Phostrol 6.7SC	Agtrol Chemical Products	6.69lbs/gal mono and dibasic sodium, potassium, and ammonium salts
Provado 1.6SC	Bayer Corp.	Imidacloprid
Quadris 2.08 SC	Syngenta Crop Protection, Inc.	22.9% Azoxystrobin
Ranman 3.34SC	ISK Biotech Corp 5970 Heisley Rd Mentor, OH 44061	Information not provided
Silwet L-77	Loveland Industries P.O. Box 7190 Greeley, CO 80632-1289	Organosilicone surfactant (polyalkyleneoxide modified)
Stimplex 0.01%	Agtrol Chemical Products	0.01% Cytokinin
Stratego 2.08EC	Bayer Corp.	Trifloxystrobin and Propiconazole
Super Tin 80WP	Griffin Corp.	80% Triphenyltin Hydroxide
YRC2894 240SL	Bayer Corp.	Information not provided